British airways

EUROPEAN DIVISION
FLIGHT OPERATIONS TRAINING

TriStar

COURSE NOTES

PREFACE

1 Lecture Notes are issued to each student for retention and are only intended to be used in conjunction with Lectures.

2 The Notes are not intended to replace official Manuals neither can they be used as official working data. No attempt will be made to keep notes amended after completion of a course, and it will not be possible to replace copies that are lost.

3 Information is up to date at the time of issue but may require revision in the light of modifications. Instructors will indicate these points during Lectures.

A.J. Timmins
Assistant Manager Pilot Technical Training

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A.P.U.

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9 FIRE PROTECTION
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AMALGAMATED LOOSE LEAF LTD LONDON REF C1*P

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TRISTAR ABBREVIATIONS

ACM	Air Cycle Machine
ADC	Air Data Computer
ADI	Attitude Director Indicator
AFCS	Avionic Flight Control System
AGS	Auto Ground Spoilers
AIDS	Airborne Integrated Data System
A/L	Approach/Land
ALPHA MODE	Angle of Attach Sensing
ALTN	Alternate
AM	Amplitude Modulation
AOA	Angle of Attack
APFDS	Autopilot Flight Director System
APU	Auxiliary Power Unit
AS/M	Airspeed/Mach Indicator
ATM	Air Turbine Motor
ATS	Auto Throttle System
AVM	Airborne Vibration Monitor
BITE	Built in Test Equipment
BPP	Bus Protection Panel
BRG	Bearing
BTB	Bus-Tie Breaker
CMD	Command (A/P)
CPSR	Compressor
CSD	Constant Speed Drive
CWS	Control Wheel Steering (A/P)
DEDP	Data Entry and Display Panel
DEV	Deviation
DFDR	Digital Flight Data Recorder
DH	Decision Height
DIFF	Differential Protection
DLC	Direct Lift Control
DMU	Data Management Unit
ECS	Environmental Control System
EFDARS	Expandable Flight Data Acquisition and Recording System
EHFDP	Engine Health Fixed Data Panel
EPR	Engine Pressure Ratio
FASC	Forward Avionics Service Centre
FESC	Forward Electronics Service Centre
FCES	Flight Control Electronic System
FDAU	Flight Data Acquisition Unit
FIRM	Fault Isolation Reporting Method
GB	Generator Breaker
GCU	Generator Control Unit
GFR	Generator Field Relay
GW	Gross Weight
HDG	Heading
HSI	Horizontal Situation Indicator
IDG	Integrated Drive Generator
KVAR	Kilovolt/Amps Reactive
KW	Kilowatts
LRS	Load Relief System (Flap)
LSB	Lower Side Band
MESC	Mid Electrical Service Centre
MLG	Main Landing Gear
MWS	Master Warning System
NLG	Nose Landing Gear
PCU	Passenger Control Unit
PDU	Power Drive Unit
PFCS	Primary Flight Control System
PMG	Permanent Magnet Generator
PSU	Passenger Service Unit
PTU	Power Transfer Unit
PVD	Para-Visual Director
RA	Radio Altimeter
RAT	Ram Air Turbine (Hydraulic)
RCCB	Remote Controlled Circuit Break
RDDMI	Radio Digital Distance Magnetic Indicator
SAS	Stability Augmentation System
SCS	Speed Control System
SPI	Surface Position Indicator
SYNCH	Synchronise
TBV	Turbine Bypass Valve
TGT	Turbine Gas Temperature
T/R	Transformer Rectifier
USB	Upper Side Band
VMO	Maximum Air Speed
XFMR	Transformer
XFR	Transfer

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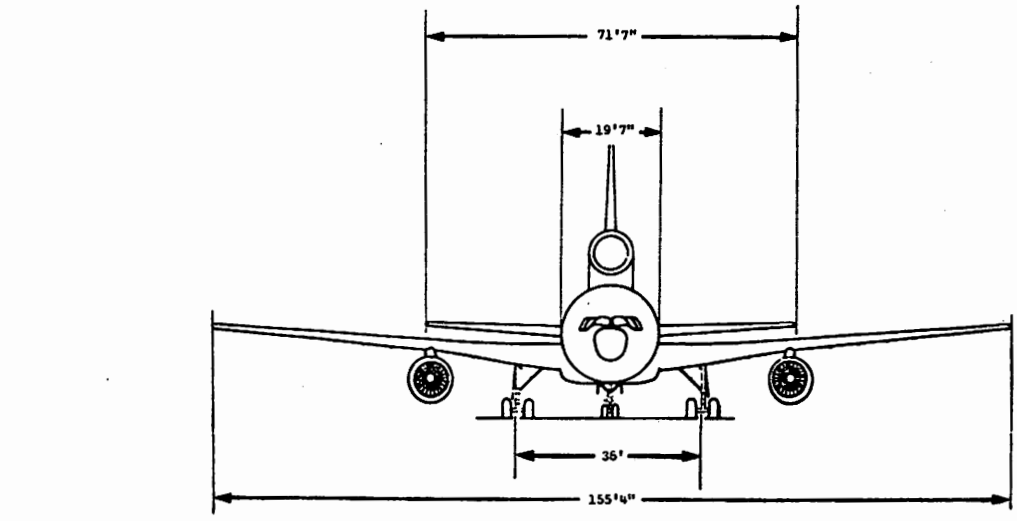
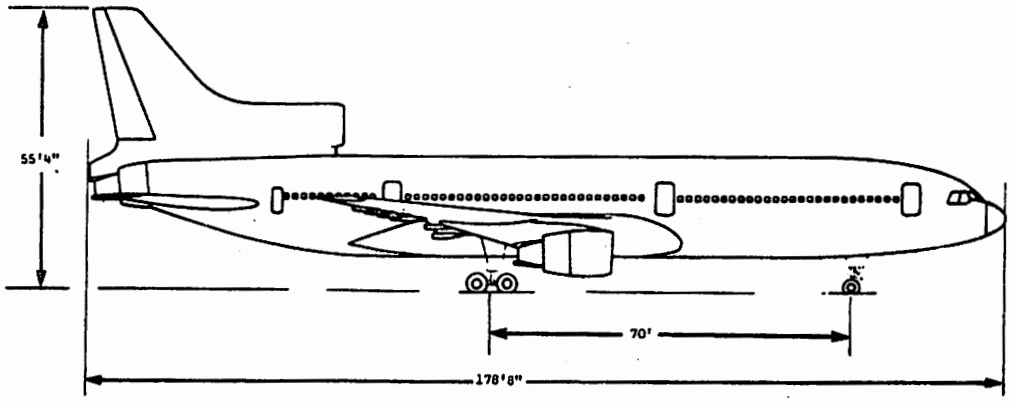
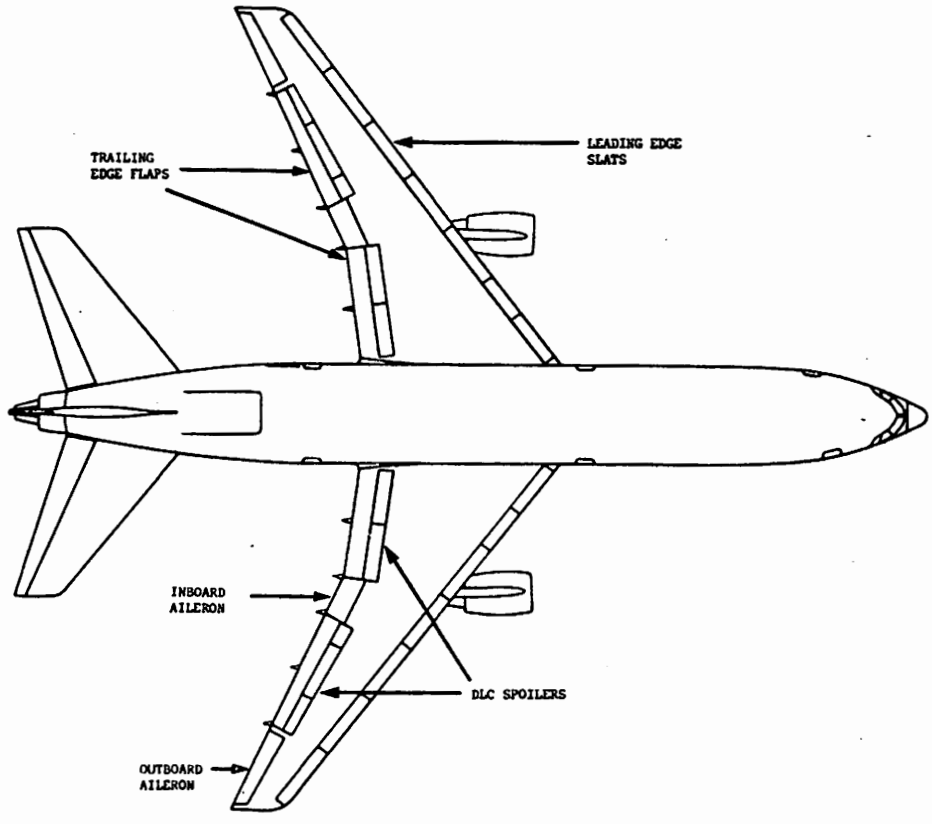
GENERAL DIMENSIONS



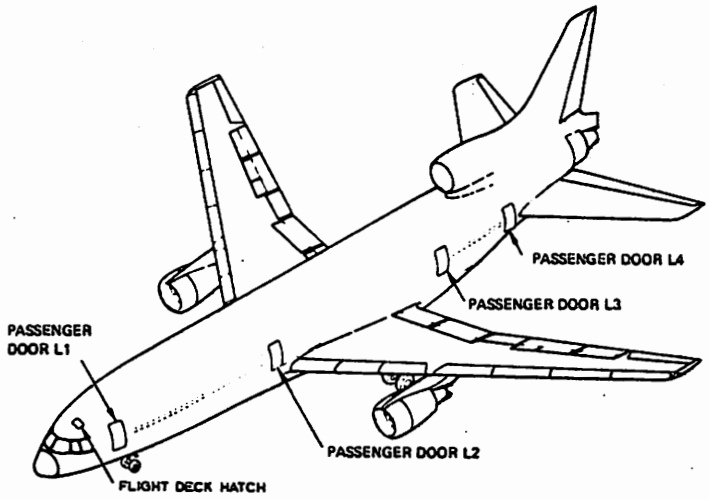


PRIMARY FLIGHT CONTROLS



DOOR IDENTIFICATION

There are eight cabin doors, four on each side. There are no overwing emergency exits.

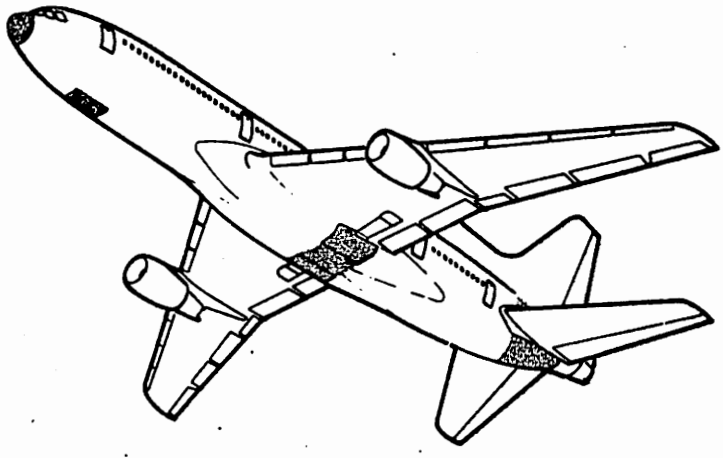


Doors are numbered consecutively from front to rear. Prefix L for left and R for the right side of the aircraft. They can all be used for entry and emergency exits.

UNPRESSURIZED AREAS

All areas of the fuselage are pressurized with the exception of:-

(i) Nose Radome.
(ii) Wheelwells.
(iii) Environmental Control System Centre.
(iv) Hydraulic Service Centre.
(v) Aft fuselage (including A.P.U. Bay).

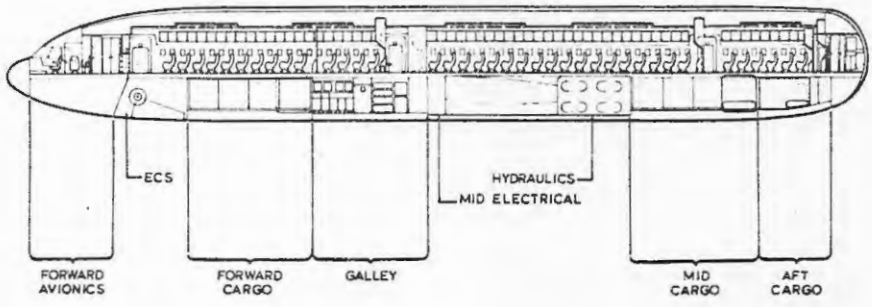


SERVICE COMPARTMENTS

There are four separate service centre compartments located in the underfloor section of the fuselage:-

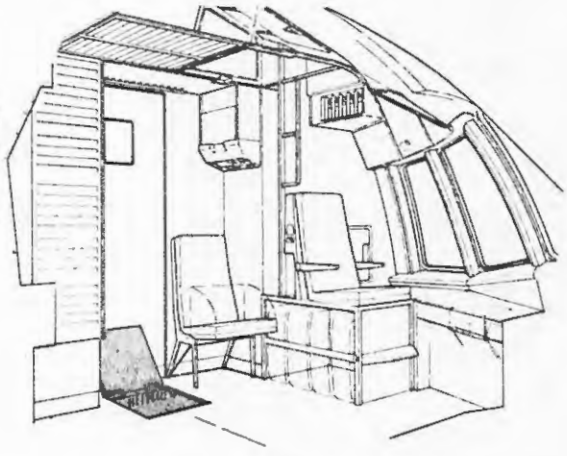
(i) Forward Avionics Centre.
(ii) Environmental Control System Centre.
(iii) Mid Electrical Service Centre.
(iv) Hydraulics Service Centre.

The Forward Avionics and Mid Electrical Service centres are accessible in flight, each being equipped with a service interphone jack to allow communications between Flight Deck and other service areas.



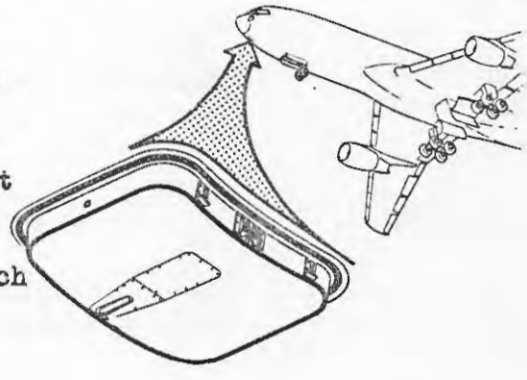
FORWARD AVIONICS
Access in Flight

The forward avionics centre is accessible in flight from an opening in the floor of the Flight Deck.



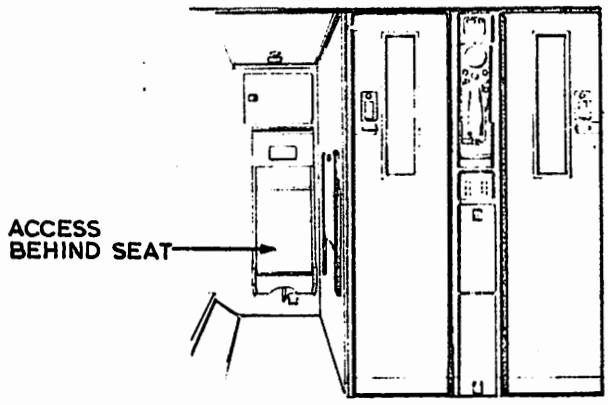
FORWARD AVIONICS
External Access

The hatch when opened moves up and aft, providing access. Inside the compartment there is a fixed ladder which via the flight deck floor hatch allows access to the flight deck.



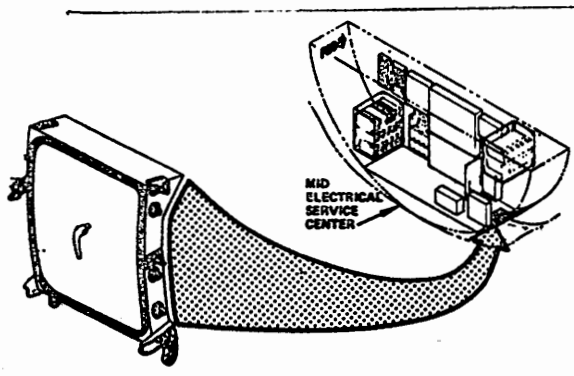
MID ELECTRICAL Access in Flight

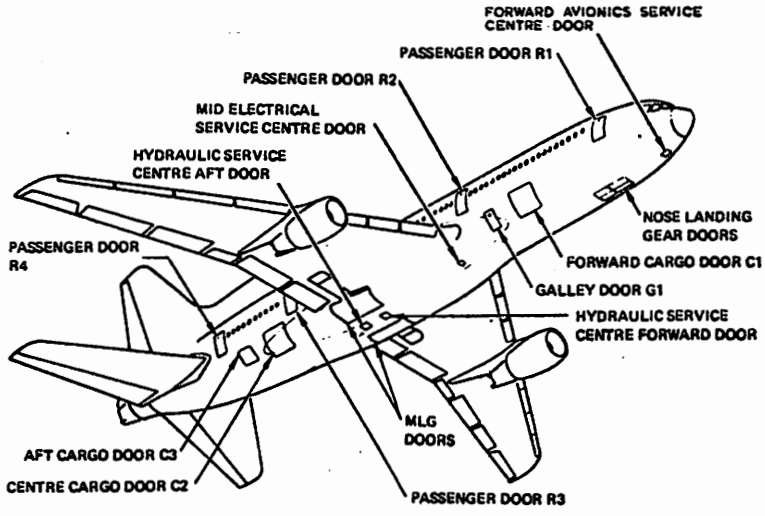
The Mid Electrical is accessible through the hatch at the aft end of the galley.



MID ELECTRICAL External Access

A double door provides access. The first giving access to a plug door that opens into the compartment.





CARGO COMPARTMENTS

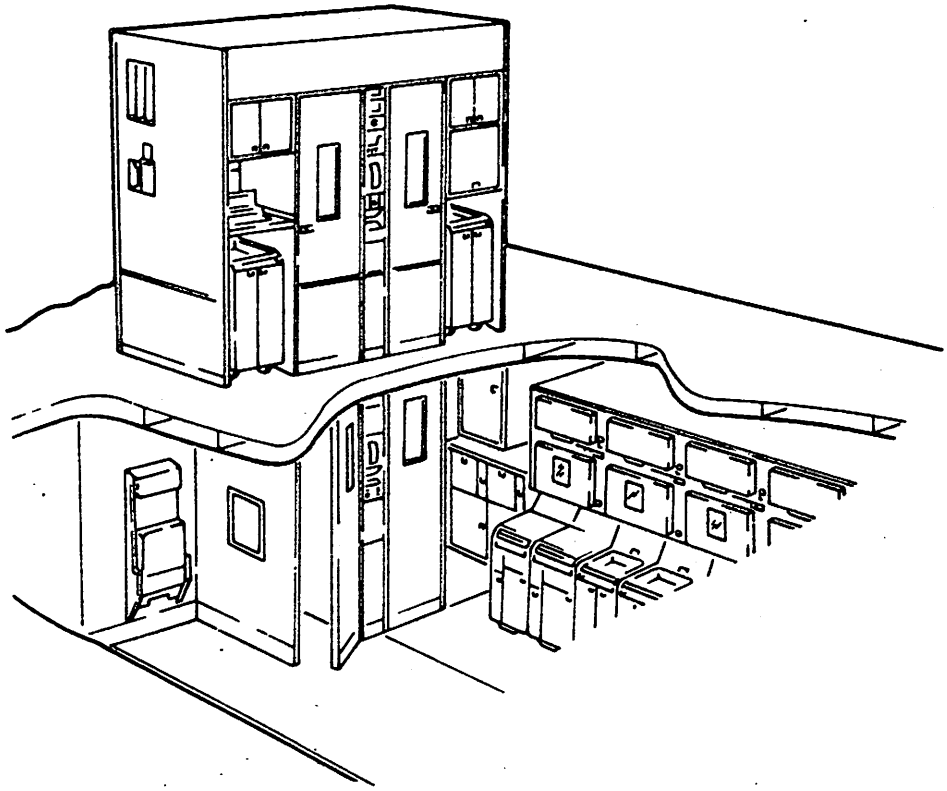
The lower fuselage contains three cargo compartments. They are equipped to handle pre loaded cargo and baggage containers.

CARGO DOORS

The compartments are accessible through doors on the right side of the aircraft. These doors being mechanically unlatched and electrically opened. The doors opening outward and upwards.

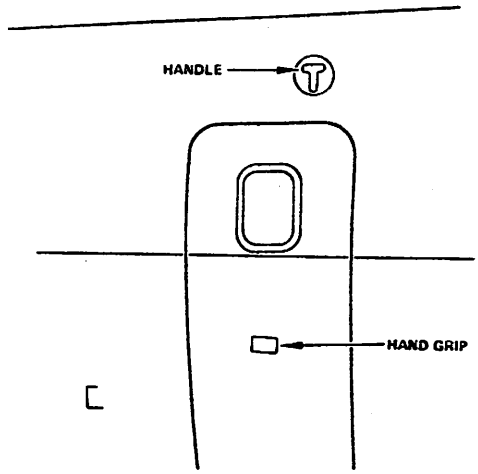
GALLEY

The galley is directly below the forward tourist cabin. It is accessible from the cabin via two lifts or externally through a service door. Equipment includes refrigerators, ovens and facilities for parking trollies.



GALLEY SERVICE DOOR

The service door which is located on the right side of the aircraft is opened by a handle over the door.



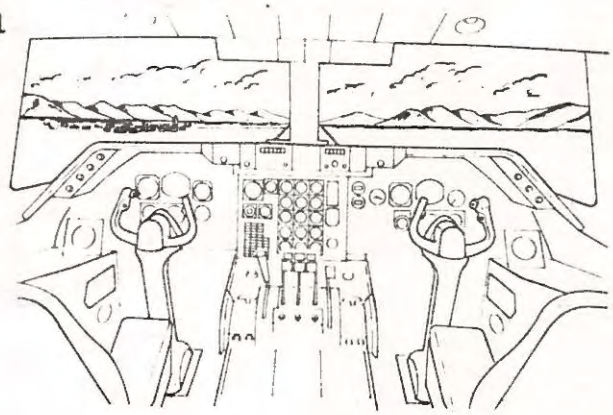
VISIBILITY

Windscreen Visibility

The windscreens are manufactured from laminated stretch acrylic, glazed with a thin layer of chemically treated glass, which provides resistance to abrasion. Stretched acrylic laminate is not prone to crazing, shattering or de-lamination. Heating is not required for the retention of birdproof characteristics nor will a bird strike seriously impair visibility.

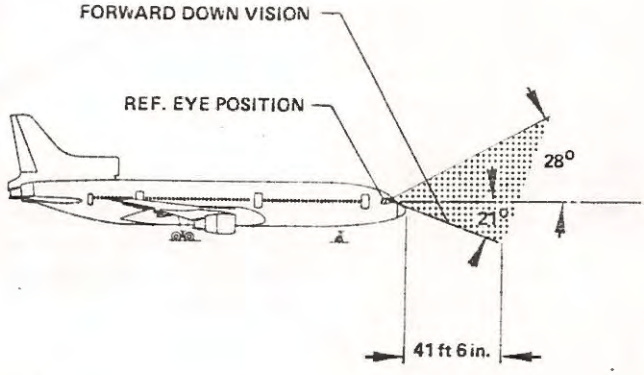
GLASS INCREASED TO 3/4"

The curved windshield allows positioning of the side posts in a manner which provides the pilots with a convenient vertical reference. The edge of the flat glareshield provides a good horizontal reference in all modes of flight.



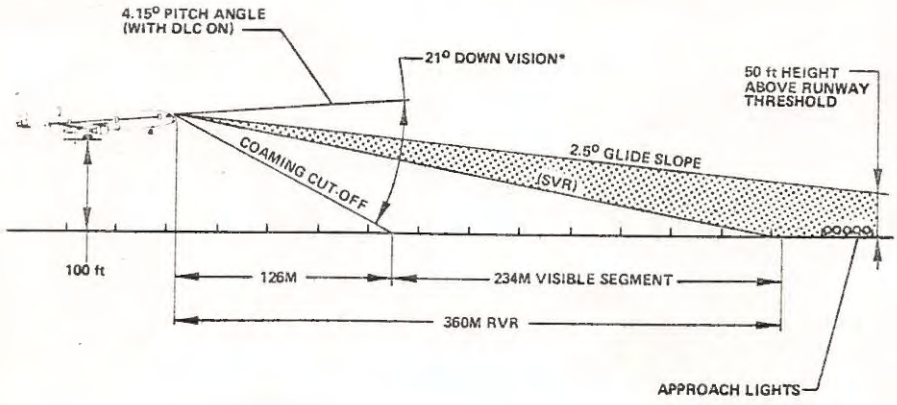
Forward Visibility

The forward visibility is illustrated with the aircraft level in the normal attitude on the ground.



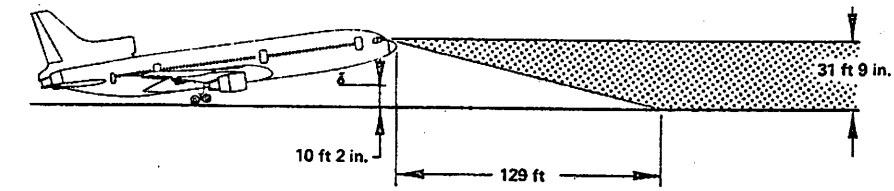
Approach Visibility

The approach visibility illustrated is with an R.V.R. of 360M or 1200'. Use of direct lift control during the approach will maintain a relatively constant deck angle. Therefore the visibility range will remain constant.

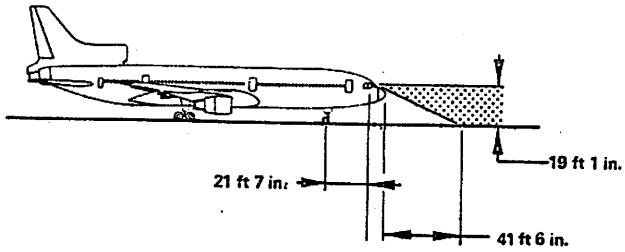


Touchdown/Rollout
Visibility

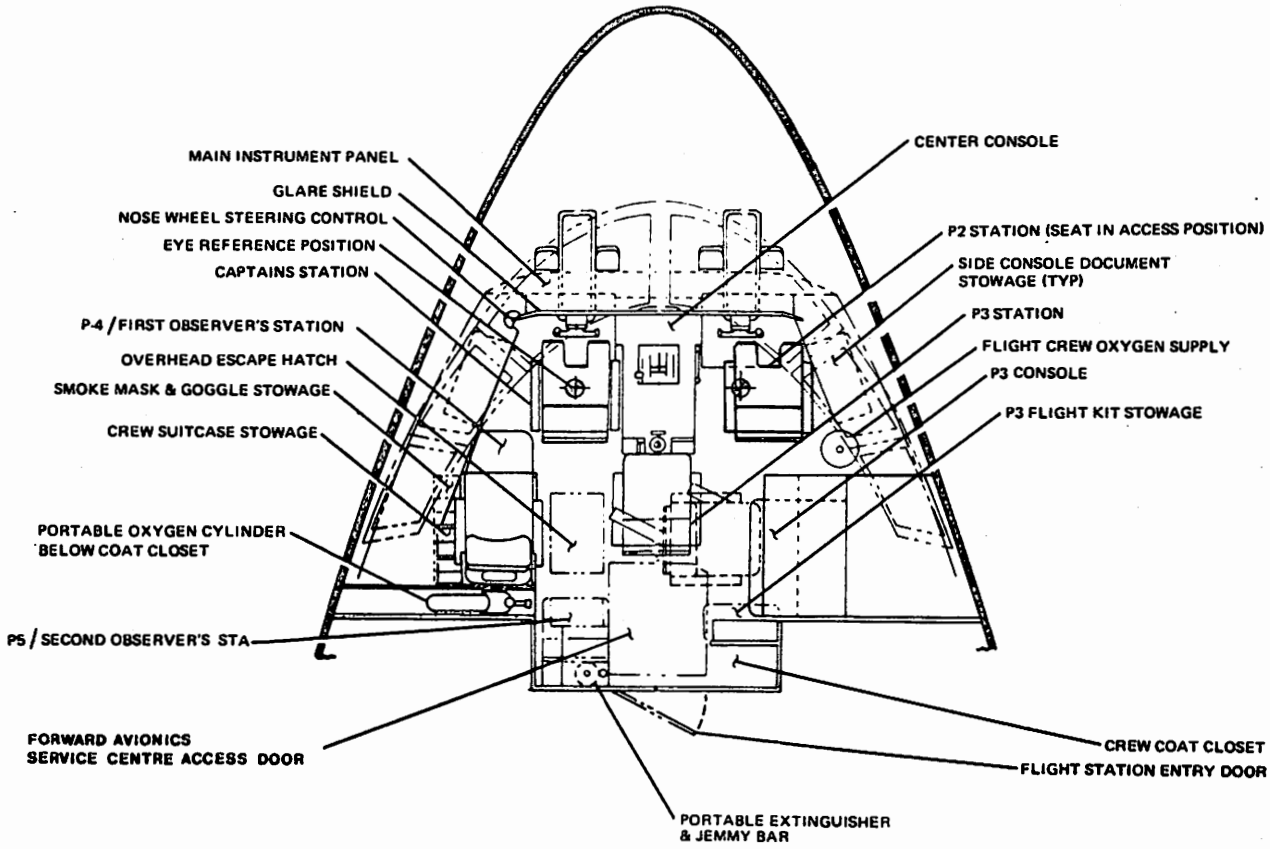
VISIBILITY – TOUCHDOWN AND ROLLOUT



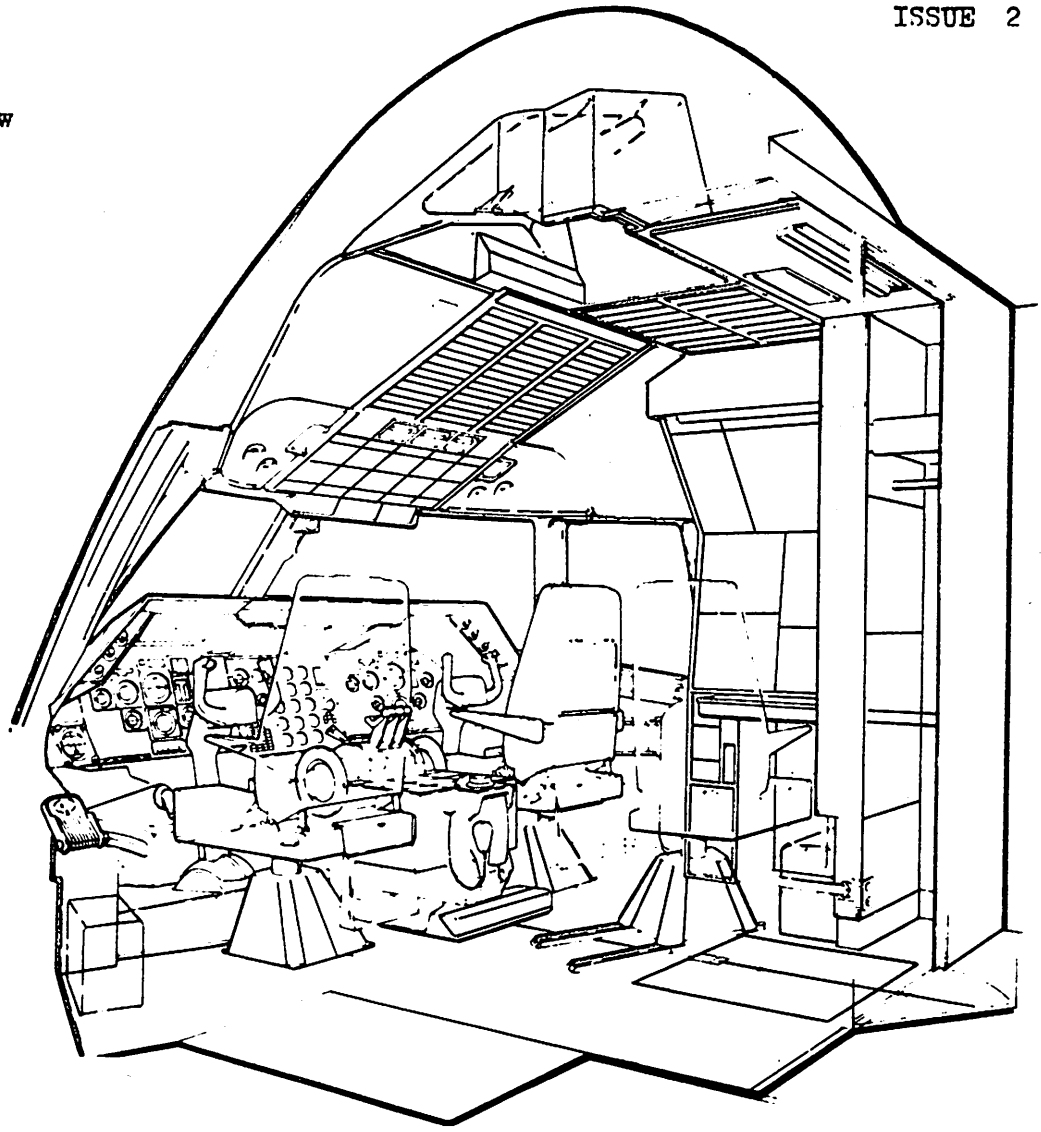
BODY ANGLE AT TOUCHDOWN POSITION
(ATTITUDE AT 8° PITCH ANGLE)



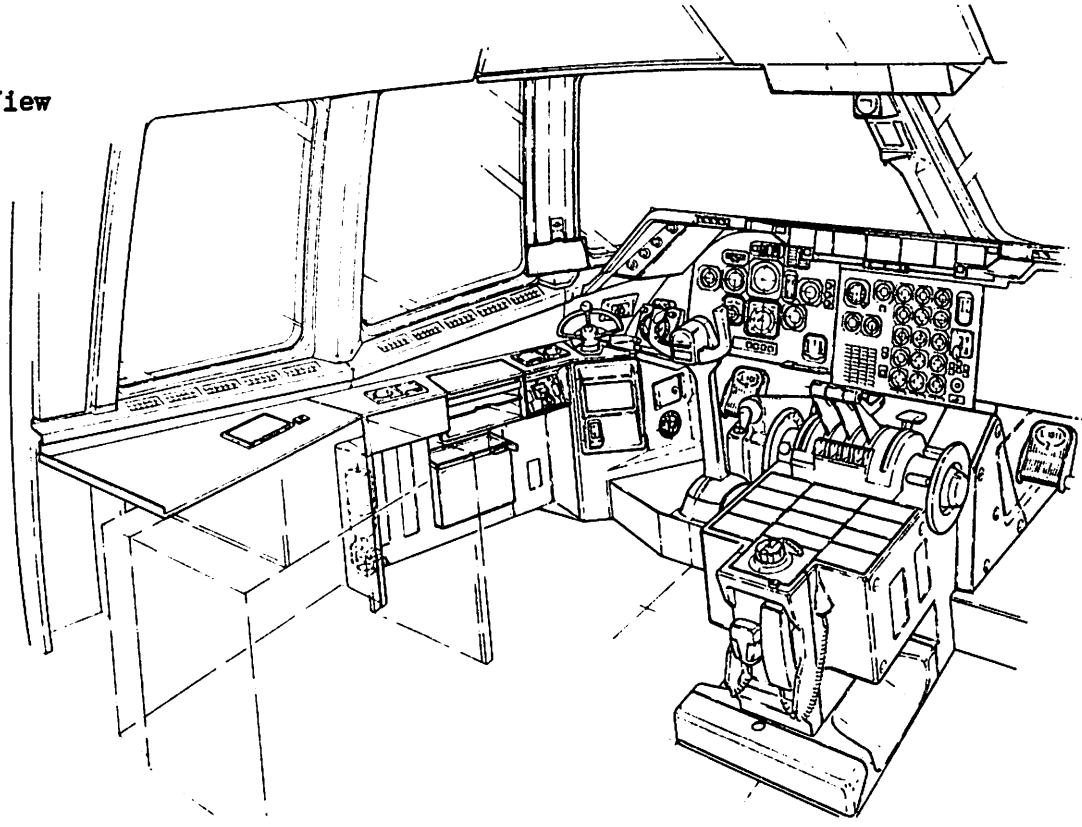
Flight Deck Arrangement.



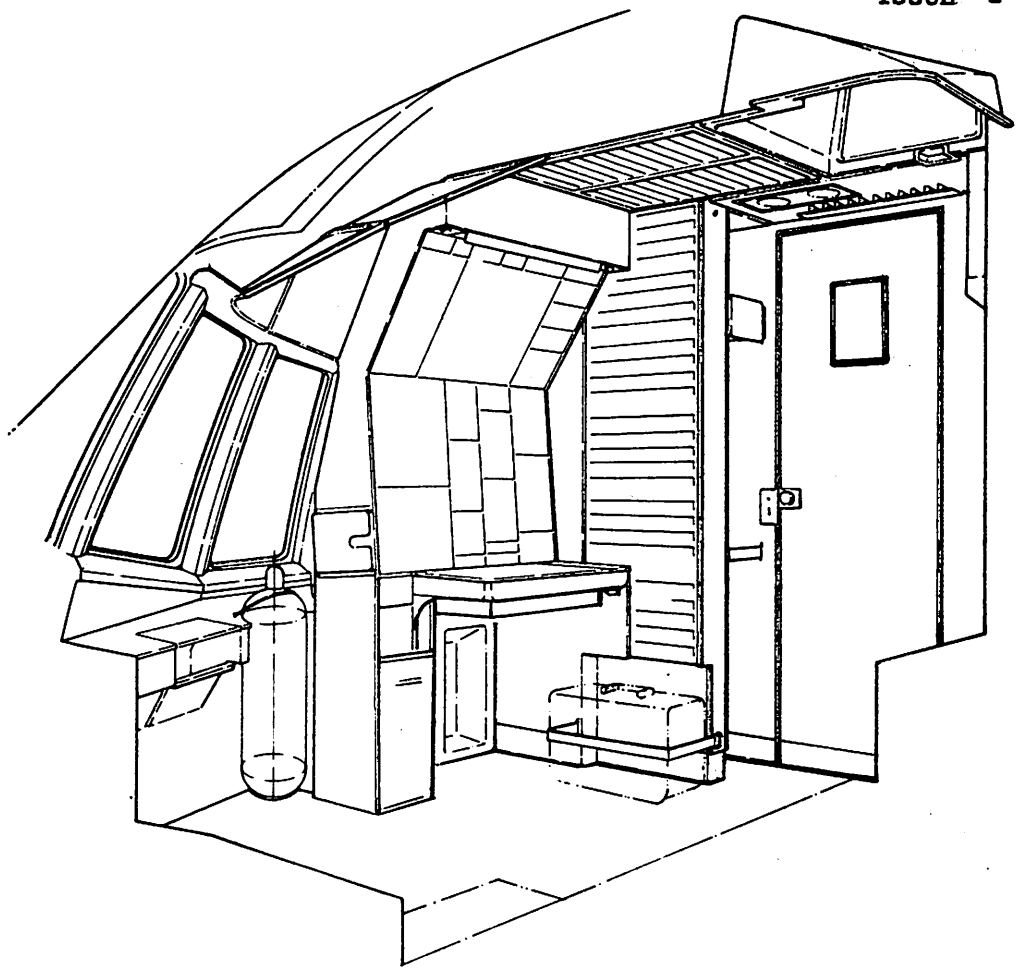
Right Forward View



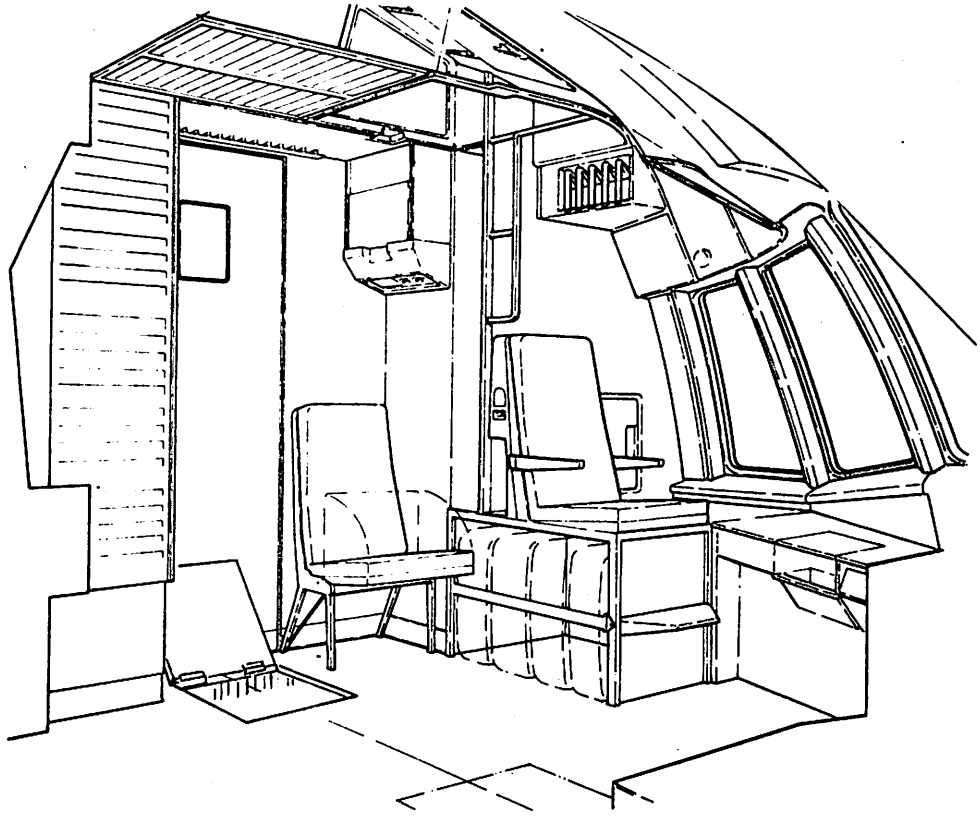
Left Forward View



Right Aft View



Left Aft View

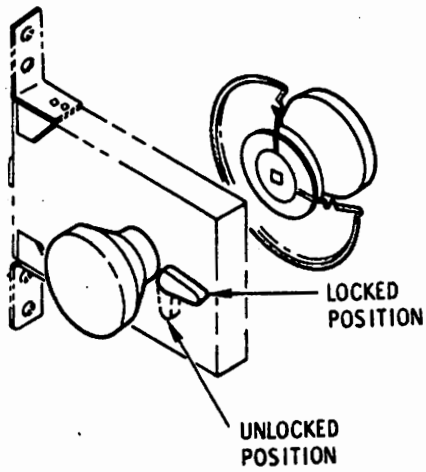


FLIGHT DECK DOOR

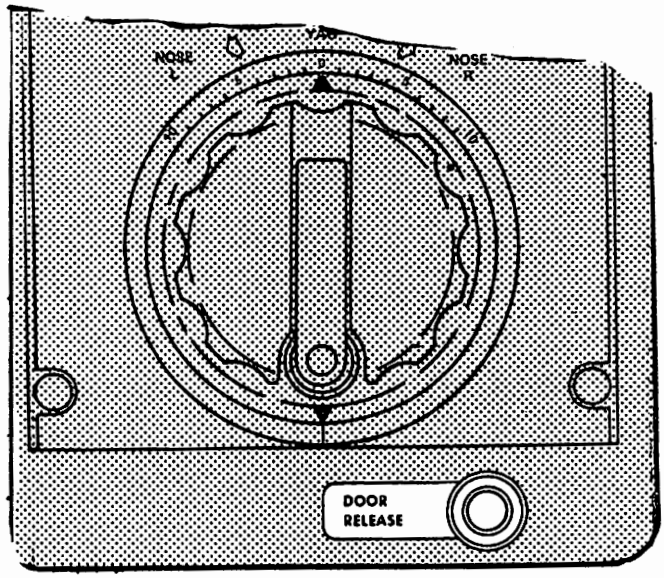
The Flight Deck door lock is electrical. A solenoid activated strike is continuously powered to keep the door locked when D.C. power is available.

There are two mechanical overrides:-

(i) Knob on inside.
(ii) Key lock on cabin side.

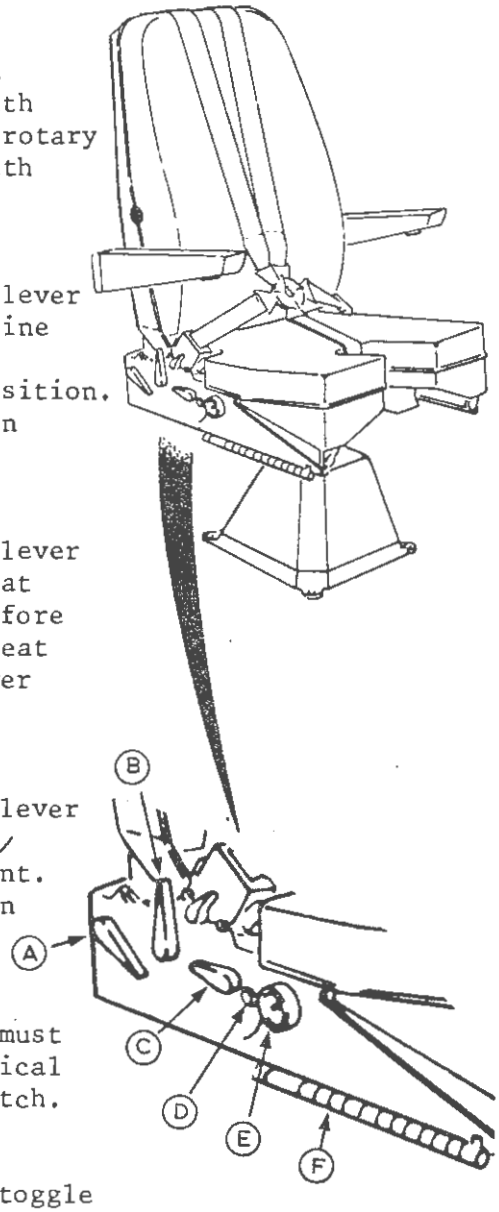


If electrical power is available, the door lock may be released by the pushbutton switch on the centre console. Tripping the appropriate C.B. will de-activate the lock.



CAPTAIN'S AND P2's SEATS

The Captain's and P2's seats are mirror image opposites, their pedestals being fixed to the floor. Vertical and lateral adjustment with horizontal travel is power actuated.



Seat Restraint

Dual shoulder harness with inertia reels, lap belt with retractor lock levers and rotary buckle and crotch strap with retractor.

Recline Control Lever

Ⓐ Holding spring loaded lever up releases seat back recline lock for manual adjustment from upright to recline position. Seat back locks in position when lever is released.

Manual Fore and Aft Control Lever

Ⓑ Holding spring loaded lever forward or aft releases seat position locks for manual fore or aft seat adjustment. Seat locks in position when lever is released.

Vertical Control Lever

Ⓒ Holding spring loaded lever up releases seat locks for manual up or down adjustment. Seat locks in position when lever is released.

Push Button Safety Switch

Ⓓ Momentary switch that must be held in to arm the vertical and longitudinal power switch.

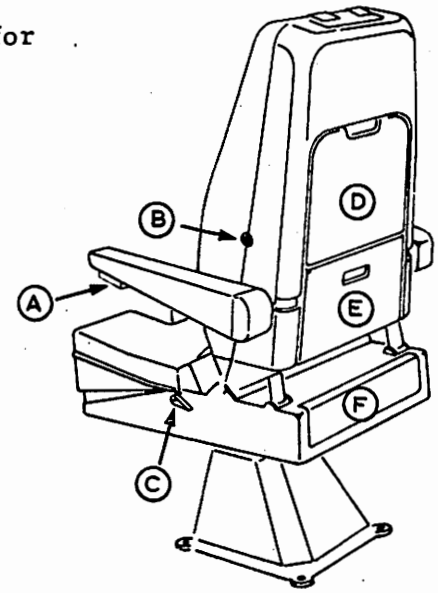
Vertical and Longitudinal Power Switch.

Ⓔ Holding four-position toggle to UP, DOWN, FWD or AFT will move seat in direction of switch position. Releasing switch locks seat in position. Switch is spring loaded to centre neutral position.

Seat Position Indicator

Ⓕ Indicates longitudinal position of seat from zero to 7 inches.

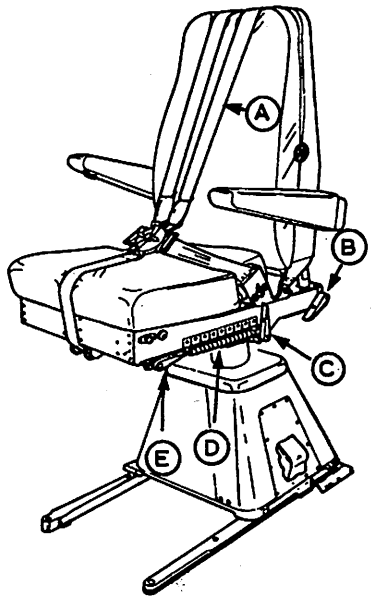
Arm Rest Adjustment Button	Ⓐ Moving spring loaded button forward releases lock for manual adjustment of armrests. Adjustments are in 3 degree steps to 12 degrees up and 3 degrees down from true horizontal. Releasing button locks armrests in position. Inboard armrest can be stowed behind seat.
Lumbar Support Knobs (2)	Ⓑ Moving both knobs up or down positions lumbar support inside seat back.
Thigh Support Control Lever	Ⓒ Holding spring loaded lever up releases thigh support for manual adjustment.
Life Vest Storage	Ⓓ
Smoke Goggle Storage	Ⓔ
Waste Bag Holder	Ⓕ



P3's SEAT

Seat Restraint — (A)

Recline Control Lever — (B) Holding spring loaded lever up releases seat back recline lock for manual adjustment from upright to recline position. Seat back locks in position when lever is released.



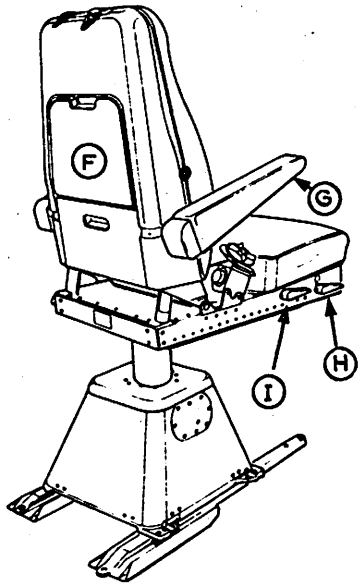
Manual Diagonal Control Lever — (C) Holding spring loaded lever forward or aft releases seat position locks for manual diagonal adjustment along the tracks from the systems station to just aft of the centre console. Seat locks in position when lever is released.

Seat Position Indicator — (D) Indicates longitudinal position of seat pan from zero to 7".

Vertical Control Lever — (E) Holding spring loaded lever up releases seat locks for manual up or down adjustment. Seat locks in position when lever is released.

Smoke Goggles and Oxygen Mask Storage — (F)

Armrest Adjustment Button — (G)

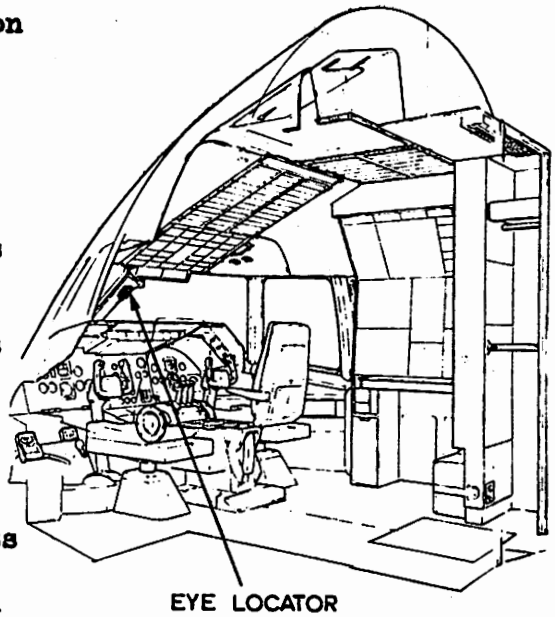


Seat Pan Longitudinal Lateral Control Lever — (H) Holding spring loaded lever up releases lock for manual longitudinal adjustment of 7 inches of the seat pan in reference to the seat pedestal. A J track underneath the seat pan provides 5 inches of lateral travel at the extreme aft end of longitudinal travel. Releasing lever locks seat in position.

Swivel Control Lever — (I) Holding spring loaded lever up releases lock for manually rotating seat. Seat swivels 210 from a position facing directly inboard (zero degrees at 9 o'clock). The seat locks at 0, 90, 135, 180 (facing out-board 3 o'clock) and 210 degrees.

PILOT'S EYE LOCATOR

The pilots' eye locator is a two-way sighting device. It is used to locate the pilot's eyes in the design eye position for optimum runway visibility and an un-obstructed view of the instrument panels. The design eye position is attained in two stages. The captain or P2 centres himself in his seat in comfortably slumped position. He rotates his head to face the locator and uses both eyes for sighting.



Operating the electric controls, he first adjusts his seat vertically. The proper height is attained when each of the two white horizontal bands is equally visible above and beneath the black triangular dividing plane.

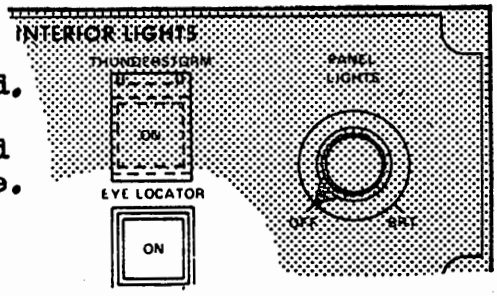
Operating the electric controls, he then adjusts his seat longitudinally (forward) without changing his body-head-eye position relationship. The proper station line is attained when the white vertical band appears equally divided by the black index rod.

Eye position error will be produced either by sighting with either eye closed, or by facing forward and rotating the eyes.

EYE LOCATOR Light Switch

IN - ON is illuminated and eye locator is powered.

OUT - ON is extinguished and locator is inoperative.



CIRCUIT BREAKERS

There are two types of circuit breaker fitted:-

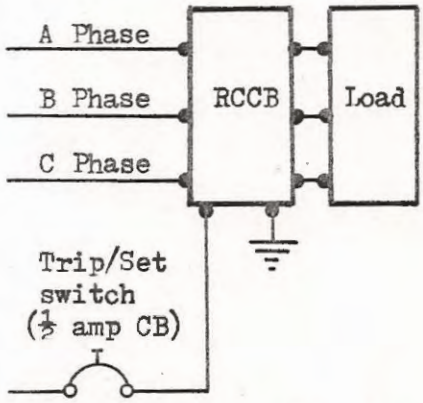
(i) Conventional trip/set type.

(ii) Remote Control Circuit Breakers (RCCB).

The conventional type is found on all Flight Deck Circuit Breaker panels. In addition to its normal function of circuit and load protection, a number of ½ amp C.B. are used to control and indicate the state of R.C.C.B.

Remote Control Circuit Breakers

A R.C.C.B. is a combination of conventional thermal sensing circuit breaker and heavy duty relay. They are used on three phase, single phase and DC circuits. Cables from main busbars to sub busbars and major system loads are protected and in some cases controlled by RCCB. Their use therefore has three main advantages.



R.C.C.B CAN ONLY BE RESET FROM THE FLT. DECK.

(i) Provides protection close to the source of power.

(ii) Eliminates many long cables.

(iii) Reduces the need for separate load control relays.

The R.C.C.B.s use ½ amp circuit breakers on the Flight Deck panels as trip/set switches, there is also a manual push button fitted to each R.C.C.B.

Operation

Main R.C.C.B. contacts may be tripped open or reset electrically by operation of the respective circuit breaker at the Flight Deck C.B. panel.

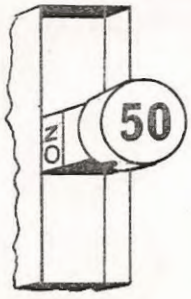
Overload

If the R.C.C.B. senses an overload, the main contacts will open thermally and send a trip signal to its respective circuit breaker on the Flight Deck C.B. panel.

After tripping the R.C.C.B. may be reset electrically by closing the C.B. If the overload persists the R.C.C.B. and C.B. will trip free and remain open until the overload condition is cleared.

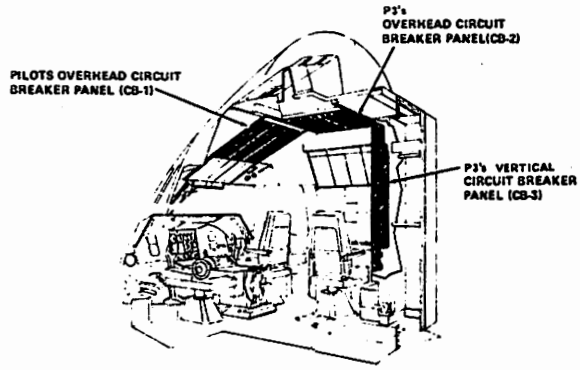
Manual

The manual pushbutton on the R.C.C.B. may be used to override the control circuit and trip or reset the main contacts. In either case a white flag on the pushbutton will indicate the reset or tripped condition.



CIRCUIT BREAKER PANELS

Eleven circuit breaker panels are installed in the Flight Deck. These are combined to form three primary panels, and are identified as CB-1, CB-2, and CB-3 panels.



CB-1 or Pilots Overhead Panel.

Contains important flight operations breakers within easy reach of all 3 pilots. Protection is provided for communications, navigation, flight controls and fire detection. Bus power being Essential, Standby or Battery.

CB - 2 or P3's Overhead Panel

Includes circuit breakers for such systems as Flight Deck lights, ground service power, passenger service, hydraulics and anti-ice.

CB - 3 or P3's Vertical Panel

Is the aft panel. Includes circuit breakers for E.C.S., pressurisation, fuel system, interior and exterior lights, A.C. and D.C. power control.

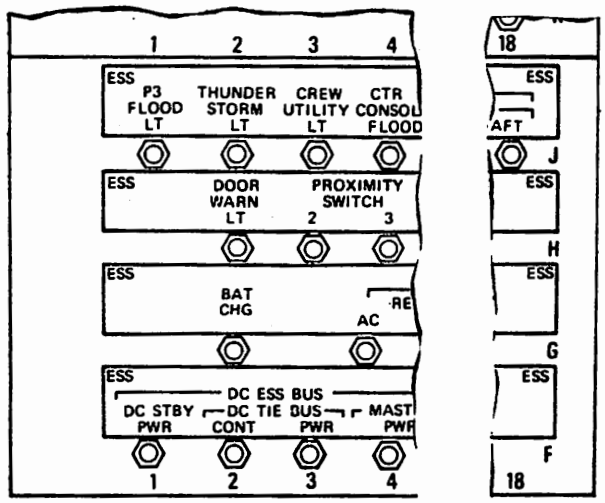
Location

An alpha numeric Grid Reference is used to locate the individual circuit breakers, e.g.

DC TIE BUS PWR 3-F-3

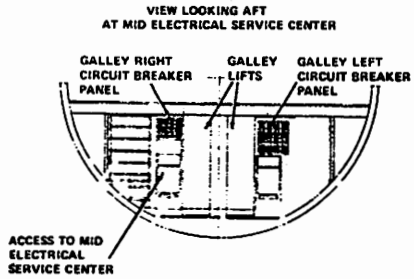
3 = CB3
F = row F
3 = third breaker from left.

Power supplies are readily identified.



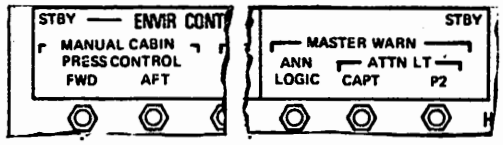
Left and Right Galley Panels

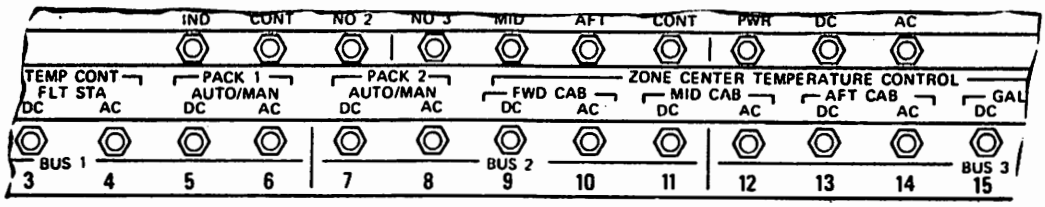
The Galley Circuit Breaker panels contain C.B.s related to passenger service and ground operation.



Power Sources

System power sources are identified, in either the upper left or right corners of the row, with a vertical line between CB description to separate systems or function. In addition on CB2 and CB3 the vertical lines between the circuit breakers identify which bus is the power source.





		CB Panel No	Row	Position
NO 1 AC BUS BAR	T/R Power	3	E	16
	B3 AC Hydraulic Pump	2	L	12
	Outbd Boost Pump 2L	3	U	5
	Outbd Boost Pump 2R	3	U	6
	Pass Svce Bus 1L	3	Z	9
	Pass Svce Bus 1R	3	Z	10
	FLIGHT STATION PWR BUS I	3	E	9
	Load Cont and Fail Ind Bus 1	3	D	9,10,11
	Start Ign Sys A, Eng No 1	3	N	6
	Fuel Flow, Eng No 1	3	P	5
	Fuel Cont Ampl, Eng No 1	3	P	6
	Oil Temp Eng No 1	3	P	1
	Tach N1 Eng No 1	3	P	2
	Tach N2 Eng No 1	3	P	3
	Eng Vib All Engines	3	R	2
	ECS Air Temp Ind	3	V	1
	Temp Cont Flt Sta AC	3	V	4
	Pack 1 Auto/Man AC	3	V	6
	Ins 3 Htr	1	E	25
	Fwd Lav Razor Outlet	2	A	3
	Fwd Lav Flush Pump No 1	2	B	3
	Left Window Heat Side Windows Fwd PWR	2	B	12
	Left Window Heat Side Windows Aft PWR	2	B	13
	Windshield Defog and P/2 Wiper PWR	2	C	13
	Ice Sensor AC	2	D	12
	Eye LCT and Approach Chart Lights	2	E	1
	P3 Panel Lights	2	E	2
	Ovhd and Eyebrow PNL lights	2	E	3
	Left Alpha Heat	2	E	12
	Drainmast Heater Aft, Mid	2	E	14,15
	Pitot Heat P/2 Sec	2	E	16
	R AOA	2	F	1
	Flap Load Relief Chan 1	2	H	12
	Hydraulic Qty Indicators	2	M	12
	Hydraulic Press Indicators	2	M	13
	Capt L Instrument Lighting	1	L	20
	Capt R Instrument Lighting	1	L	21
	CTR L Instrument Lighting	1	L	22
	CTR R Instrument Lighting	1	L	23
	Glareshield Panel Lighting	2	M	6
	Overhead L Panel Lighting	2	M	7
	Overhead L CTR Panel Lighting	2	M	8
	Overhead R CTR Panel Lighting	2	M	9
	Overhead R Panel Lighting	2	M	10
	Eyebrow Panel Lighting	2	M	11

	FLIGHT STATION PWR BUS I (Cont)	CB Panel No	Row	Position
NO 1 AC BUS BAR (Cont)	P3 Panel Lights, Upper No 1	3	CC	1
	P3 Panel Lights, Upper No 2A	3	CC	2
	P3 Panel Lights, Upper No 2B	3	CC	3
	P3 Panel Lights, Upper No 3	3	CC	4
	P3 Panel Lights, Lower No 1A	3	CC	5
	P3 Panel Lights, Lower No 1B	3	CC	6
	P3 Panel Lights, Lower No 1C	3	CC	7
	P3 Panel Lights, Lower No 1D	3	CC	8
	P3 Panel Lights, Lower No 2	3	CC	9
	P3 Panel Lights, Lower No 3	3	CC	10
AC GROUND SERVICE BUS	Fuel Qty Ind 1	3	T	2
	Fuel Qty Ind 2L	3	T	3
	Fuel Qty Ind 2R	3	T	4
	Fuel Qty Ind 3	3	T	5
	Wheelwell Lt PWR	2	K	2
	Wing Position Lights Fwd No 1	2	K	3
	Wing Position Lights Fwd No 2	2	K	4
	Wing Position Lights Aft L	2	K	5
	Wing Position Lights Aft R	2	K	6
	Fwd Closet and Lav Lt	2	K	11
	Fwd Service CTR Lt	2	K	9
	Ovhd Flood Flt Sta Lt	2	K	10
AC ESSENTIAL	Ess PWR Generator No 1	3	E	12

		CB Panel No	Row	Position
NO 1 D.C. BUS	Side Window Left Heat Cont	2	B	14
	P/2 Wiper Cont	2	C	15
	Ice Sensor DC	2	D	13
	Eng 1 Anti-Ice	2	D	15
	Drainmast Cont Ind	2	E	13
	Stick Shaker	2	F	2
	Tail Skid Cont	2	F	12
	Tail Skid Ind	2	F	13
	P3 Ind Light Test 1	2	H	1
	P3 Ind Light Test 2	2	H	2
	P3 Ind Light Test 3	2	H	3
	P3 Ind Light Test 4	2	H	4
	P3 Ind Light Test 5	2	H	5
	Flap Load Relief Ind	2	H	13
	DLC Servo A	2	H	14
	DLC Servo B	2	H	15
	Pilots' Ind Lt	2	J	2
	Ind Lt P3 Panel Upper	2	J	3
	Rudder Servo A	2	K	12
	Rudder Servo B	2	K	13
	Rudder Servo C	2	K	14
	Hydraulic ATM Pump & Ind Sys B	2	L	13
	Hydraulic PTU Cont & Ind Sys B-A	2	L	14
	Hydraulic Sys A RSVR	2	M	14
	Hydraulic Sys A Pump	2	M	15
	TIE Bus Cont Bus 3	3	A	11
	TIE Bus PWR Bus 1	3	A	12
	Start Air Valve Eng No 1	3	N	3
	Gnd Idle Eng No 1	3	N	2
	Rev Ind, Eng No 1	3	N	4
	Oil Low Press Light, Eng No 1	3	N	5
	Fuel Low Press, Eng No 1	3	P	4
	Eng Vib Lt	3	R	3
	Wheelwell Fire Detector Loop A	3	S	1
	Wheelwell Fire Detector Loop B	3	S	2
	Tank Valve, Eng 1	3	T	6
	Emer and L X-Feed Eng 1	3	T	7
	Inbd Pump Ind	3	U	2
	Defuel 2L and 2R	3	U	3
	Pack Flow Ind	3	V	2
	Temp Cont Flt Sta DC	3	V	3
	Pack 1 Auto/Man DC	3	V	5
	Hot Air Manif Temp Ind	3	W	5
	Hot Air Manif Temp Cont	3	W	6
	Hot Air Manif ISLN No 2	3	W	7
DC GROUND SERVICE BUS	Wheelwell Lt Cont	2	K	1
	Gnd Svce Intph	2	L	1
	Mech Call	2	L	2
	VHF No 2	2	L	4
	Avionics Air Mon	2	L	5
	Bat Chg Intlk	2	L	6

		CB Panel No	Row	Position
DC GROUND SERVICE BUS (Cont)	Service Outlet DC	2	J	7
	Cabin and Galley Intph	2	L	7
	Mlg Gnd Sense	2	L	8
	ΔP & RSVR Temp Ind	2	L	9
	AC Hyd Motor Ind	2	L	10
	Refuel Flood Lt	2	L	11
	Gnd Svce Galley Ext	3	A	17
	APU TR PWR	3	B	11
	Gnd Svce Bus Controller	3	B	14
	Gnd Svce Bus Controller	3	B	14
	APU Gen Cont Unit	3	B	17
	Cont & PRI FW Sov APU PWR	3	B	15
	Audio Cont Capt & P/3	3	C	16
	Audio Cont P/2 & OBS	3	C	17
	Flt Intph Ampl	3	C	18
	Fuel Qty Ind Test	3	T	1

		CB Panel No	Row	Position
NO 2 AC BUS BAR	Inbd Boost Pump Tank 1	3	U	7
	Inbd Boost Pump Tank 2L	3	U	8
	Inbd Boost Pump Tank 2R	3	U	9
	Inbd Boost Pump Tank 3	3	U	10
	T.R 2	3	E	17
	Pass Svce Bus 2	3	Z	10
	Windshield Left Heat PWR	2	B	16
	FLIGHT STATION PWR BUS 2	3	E	10
	Water Heater FWD	2	A	7
	FWD Lav Flush Pump No 2	2	B	6
	Instr Flight Lights P/2	2	E	5
	Pitot Heat P/2 Prim	2	E	17
	Pitot Heat Capt Sec	2	E	18
	Total Temp L	2	E	19
	Wing Flood Lights	2	G	3
	Wing Landing Light LH	2	G	9
	Runway Turnoff LH Lights	2	G	4
	Strobe Lights	2	G	5
	Nose Gear Lt Land	2	G	7
	Nose Gear Lt Taxi	2	G	8
	Speed Control No 2	1	A	20
	Yaw SAS No 2	1	A	23
	Pitch and Roll No 2	1	A	24
	Trim Agmt AC No 2	1	A	25
	Altn Adi No 2	1	E	19
	Capt RDDMI - 2	1	E	20
	Vert SP Ind No 2	1	E	21
	Ins-3/Gyro-3 No 2	1	E	24
	Ins-3 Htr No 2	1	E	25
	Area Nav No 2	1	E	26
	IAS Mach P/2 No 2	1	F	19
	ADI No 2 P/2	1	F	20
	HSI No 2 P/2	1	F	21
	Altm No 2 P/2	1	F	22
	SAT/TAS No 2	1	F	27
	ILS No 2	1	G	22
	Dir Gyro No 2	1	G	23
	Ins/Vert Gyro No 2	1	G	24
	Ins Heater No 2	1	G	25
	CMPS CPLR No 2	1	G	26
	Air Data CMPTR No 2	1	G	27
	Load Cont and Fail Ind Bus 2	3	D	13
	Start Ign Sys A, Eng No 2	3	N	12
	Oil Temp Eng No 2	3	P	7
	Fuel Flow, Eng No 2	3	P	11
	Fuel Cont Ampl, Eng No 2	3	P	12
	Tach N1 Eng 2	3	P	8
	Tach N2 Eng 2	3	P	9
	Eng Out Ind All Engines	3	R	7
	Cont Ign Sys A, All Engines	3	R	8
	Cont Ign Sys B, All Engines	3	R	9

		CB Panel No	Row	Position
NO 2 AC BUS BAR (Cont)	FLIGHT STATION PWR BUS 2 (Cont)			
	Oil Press, all engines	3	R	10
	Tat all engines	3	R	12
	Pack 2 Auto/Man Ac	3	V	8
	Fwd Cabin AC Temp Cont	3	V	10
	P/2 L Instrument Lighting	1	L	24
	P/2 R Instrument Lighting	1	L	25
NO 2 AC RADIO BUS	No 2 Radio Bus A ϕ	3	AA	14
	No 2 Radio Bus B ϕ	3	AA	15
	No 2 Radio Bus C ϕ	3	AA	16
	HF No 2 AC	1	C	21
	Weather Radar Ind No 2	1	D	20
	Weather Radar Rt No 2	1	D	21
	Radio Altm No 2	1	D	22
	DME No 2	1	D	23
	Instr Cmprn Monitor	1	D	26
	ATC No 2	1	G	21
	Instr XFMR No 3	1	D	27
	Cmps CPLR-2	1	J	19
	RDDMI-2	1	J	20
	Alt Alert-2	1	J	21
	VOR-2	1	J	22
	Surf Posn Ind	1	J	23
	Flt Dat Rcdr	1	J	24
	3 Vac Stby Horiz Lt	1	J	27
AC ESSENTIAL	Ess PWR Gen 2	3	E	17

		CB Panel No	Row	Position
NO 2 DC BUS	Lav Jet Pump	2	A	4
	Windshield Left Heat Cont	2	B	15
	Anti-Ice VHF Ant	2	D	18
	Anti-Ice Eng 2	2	D	19
	Wing Flood Lt Cont	2	F	3
	Strobe Lt Cont	2	F	4
	Fire Ext Lt	2	F	7
	Gear Truck Level	2	F	16
	Gear Cont No 1	2	F	17
	Nose Gear Lt Cont	2	G	6
	Parking Brake No 1	2	G	18
	Brake Temp Ind DC	2	G	19
	Capt Ind Lt Test 1	2	H	8
	Capt Ind Lt Test 2	2	H	9
	Stabilizer Servo LB	2	H	16
	Stabilizer Servo RC	2	H	17
	Ind Lt P/3 Panel Lower	2	J	4
	Spoiler Servo A2L	2	J	15
	Spoiler Servo B1, 4, 6 L & R	2	J	16
	Spoiler Servo C3, 5, L & R	2	J	17
	Spoiler Servo D2R	2	J	18
	Rudder Mech LMTR A	2	K	15
	Rudder Mech LMTR B	2	K	16
	AFCS Warning Capt	2	K	18
	PTU Cont & Ind Sys C-D	2	L	15
	Rudder Fusing Sys	2	L	16
	Hydraulic Sys B RSVR	2	M	16
	Hydraulic Sys B Pump	2	M	17
	Hydraulic Sys C RSVR	2	M	18
	Hydraulic Sys C Pump	2	M	19
	AFCS Trim Agmt DC No 2	1	A	26
	AFCS Mode Ind	1	B	19
	AFCS No 2 Aft Coupler	1	B	27
	VHF-DC VOR RCVR No 2	1	G	19
	VHF-DC Preamp No 2	1	G	20
	T1E Bus Cont Bus 1 DC PWR	3	A	9
	T1E Bus PWR Bus 2 DC PWR	3	A	13
	Controller Bus 2 APU PWR	3	B	13
	Control and PRI F/W SOV Bus 2 APU PWR	3	B	16
	Gnd Idle Eng No 2	3	N	8
	Start Air Valve, Eng No 2	3	N	9
	Rev Ind, Eng No 2	3	N	10
	Oil Low Press Light, Eng No 2	3	N	11
	Fuel Low Press, Eng No 2	3	P	10
	Tgt Warn all Engines	3	R	11
	Tank Valve, Eng No 2	3	T	9
	Sec Emer C X-Feed Eng No 2	3	T	10
	Defuel 1	3	U	11
	Pack 2 Auto/Man DC	3	V	7
	Fwd Cabin Temp Control DC	3	V	9
	Mid Cabin Temp Control DC	3	V	11

		CB Panel No	Row	Position
NO 2 DC BUS	Hot Air Manif Isln No 3	3	W	8
	Cargo Temp Fwd, Mid	3	W	9
	Cargo Temp, Aft	3	W	10
	Floor Heat Cont	3	W	11
	Cabin Pressure Auto Cont	3	X	9
	IDG Oil Low Press	3	AA	17
NO 2 DC RADIO BUS	No 2 Radio Bus Master Cont	3	AA	12
	No 2 Radio Bus DC	3	AA	13
	HF Comm No 2 DC	1	C	19
	VHF Comm No 3	1	C	23
	ADF No 2	1	D	24

		CB Panel No	Row	Position
NO 3 AC BUS BAR	Ess Power Bus 3	3	E	14
	T/R 3	3	E	18
	Outbd Boost Pump 1	3	U	13
	Outbd Boost Pump 3	3	U	14
	Floor Heat PWR	3	W	12
	Pass Svce Bus 3	3	Z	16
	Right Windshield Heat PWR	2	B	19
	C3 AC Hydraulic Pump	2	L	22
	Flight Station PWR Bus 3	3	E	11
	Load Cont and Fail Ind Bus 3	3	D	16
	Start Ign Sys A, Eng No 3	3	N	18
	Oil Temp Eng 3	3	P	13
	N1 Tach Eng No 3	3	P	14
	N2 Tach Eng No 3	3	P	15
	Fuel Flow, Eng No 3	3	P	17
	Fuel Cont Ampl, Eng No 3	3	P	18
	Fuel Temp, all engines	3	R	13
	Oil Qty, all Engines	3	R	14
	Mid-cabin AC Temp Cont	3	V	12
	Aft Cabin Temp Cont AC	3	V	14
	Galley Temp Cont AC	3	V	16
	Pack 3 Auto/Man AC	3	V	18
	Duct Area OVHT Det AC	3	W	14
	Cabin Pressure Cont PWR Auto	3	X	10
	Cabin Pressure Cont Stby PWR	3	X	12
	Outflow Valve Fwd	3	X	14
	Outflow Valve Aft	3	X	17
	Fwd Lav Flush Pump No 3	2	B	9
	Right Window Heat Fwd PWR	2	B	21
	Right Window Heat Aft PWR	2	B	22
	Seat Signs	2	C	9
	No Smoking Signs	2	C	10
	Ins Fan Windshield Washer Pump	2	C	21
	P/3 Instr Lts	2	E	9
	Ctr Console Pnl Lts	2	E	10
	Ckt Brkr Pnl Lts	2	E	11
	Total Temp R Anti-Ice	2	E	20
	Right Alpha Heat Anti-Ice	2	E	22
	Seat ACTR Capt and P/2	2	F	10
	Seat ACTR P/3	2	F	11
	Nose Steering	2	F	19
	Brake Anti-skid	2	F	22
	Wing Landing RH Lts	2	G	10
	Runway Turnoff RH Lts	2	G	11
	Brake Temp Ind AC	2	G	20
	Brake Press Ind	2	G	21
	Flap Load Relief Chan 2	2	H	20
	Fwd Console L Panel Lighting	2	M	1
	Fwd Console R Panel Lighting	2	M	2

		CB Panel No.	Row	Position
NO 3 AC BUS BAR (Cont)	Flight Station PWR Bus 3 (Cont)			
	Aft Console L Panel Lighting	2	M	3
	Aft Console R Panel Lighting	2	M	4
	Throt Stand Panel Lighting	2	M	5
	CB1 Panel Lighting	1	L	26
	P/3 CB 2 Panel Lts CB2	3	BB	9
	P/3 CB3 Panel Lts CB3	3	BB	10
	P/3 Instrument Panel Upper Left	3	BB	11
	P/3 Instrument panel Upper right	3	BB	12
	P/3 Instrument Panel Lower Left	3	BB	13
	P/3 Instrument Panel Lower Right	3	BB	14

		CB Panel No.	Row	Position
NO 3 DC BUS	Aisle Lt L Lav	2	A	10
	Aisle Lt R Lav	2	A	11
	Windshield Right Heat Cont	2	B	18
	Side Windows Fwd Cont	2	B	20
	Host advsy Ind	2	C	8
	Ord Light	2	C	11
	Ins Cont Windshield Washer Cont	2	C	19
	Multiplex System	2	D	11
	Anti-Ice Eng 3	2	D	20
	Wind Anti-Ice Cont	2	D	22
	Side Console Floor Lights	2	E	8
	Door Latch Rlse	2	F	9
	Gear Cont No 2	2	F	18
	Parking Brake No 2	2	G	22
	Capt Ind Lt Test 3	2	H	10
	Stabilizer Servo LA	2	H	18
	Stabilizer Servo RD	2	H	19
	ASYM Brake No 1 TE Flap	2	H	21
	ASYM Brake No 1 LE Slat	2	H	22
	Aileron Servo C Inbd, L and R	2	J	19
	Aileron Servo A Inbd & Outbd, L	2	J	20
	Aileron Servo B Inbd & Outbd L and R	2	J	21
	Aileron Servo D Inbd & Outbd, R	2	J	22
	AFCS Warning P/2	2	K	19
	Hydraulic ATM Pump Cont & Ind Sys C	2	L	19
	Hydraulic Sys D RSVR	2	M	20
	Hydraulic Sys D Pump	2	M	21
	T1E Bus Cont Bus 2	3	A	10
	T1E Bus PWR Bus 3	3	A	14
	Gnd Idle Eng No 3	3	N	14
	Bus 3 Galley Power	3	A	16
	Start Air Valve, Eng No 3	3	N	15
	Rev Ind, Eng No 3	3	N	16
	Oil Low Press Light, Eng No 3	3	N	17
	Fuel Low Press, Eng No 3	3	P	16
	Eng Instr Reset All Engines	3	R	15
	Bleed Air Ind all Engines	3	R	17
	Engine 2 PRI Emer	3	R	18
	Tank Valve Eng 3	3	T	12
	Emer and R X Feed Eng 3	3	T	13
	Defuel 3	3	U	12
	Outb Boost Pump Ind	3	U	15
	Aft Cab Temp Control DC	3	V	13
	Galley Temp Control DC	3	V	15
	Pack 3 Auto/Man DC	3	V	17
	Duct Area Ovht Det DC	3	W	13
	Cabin Pressure Cont Stby	3	X	11
	IDG Oil Temp	3	AA	18

		CB Panel No.	Row	Position
AC ESSENTIAL BUS	AC Stby Bus PWR	3	F	12
	Bus Sensing AC Ess	3	F	14
	Ess T/R Power	3	F	17
	Capt PRI Pitot Heat	3	H	14
	P/3 Flood Lt	3	J	1
	Capt and P/2 Flood Lt	3	J	5
	Emer Lts Charge, left Fwd	3	J	7
	Emer Lts Charge, Left Aft	3	J	8
	Emer Lts Charge, Right Fwd	3	J	9
	Emer Lts Charge, Right Aft	3	J	10
	Capt Instr Lights	3	J	12
	CTR Instr & Glareshield Lights	3	J	13
	Anti-Coll Ext Lt, Lower LH	3	J	15
	Anti-Coll Ext Lt, Lower RH	3	J	16
	Anti-Coll Ext Lt, Upper Fwd 3	3	J	17
	Anti-Coll Ext Lt, Upper Aft	3	J	18
	TE Flap Pos Ind	3	K	16
	LE Slat Pos Ind	3	K	17
	Flight Recorder AC	3	G	5
	Ovht Loop A PWR Eng No 1	3	L	2
	Ovht Loop B PWR Eng No 1	3	L	4
	EPR Ind Eng No 1	3	L	5
	Ovht Loop A PWR Eng No 2	3	L	8
	Ovht Loop B PWR Eng No 2	3	L	10
	EPR Ind Eng No 2	3	L	11
	Ovht Loop A PWR Eng No 3	3	L	14
	Ovht Loop B PWR Eng No 3	3	L	16
	EPR Ind Eng No 3	3	L	17
	Auto Throt Servo	1	A	1
	Yaw SAS No 1	1	A	5
	Pitch and Roll No 1	1	A	6
	Trim Agmt AC No 1	1	A	7
	FCES Computers AC and AOA	1	B	5
	Spoiler Dwell AC	1	B	8
	Stby Alt.	1	E	9
	P/2 RDDMI No 1	1	E	3
	Vert SP Ind No 1	1	E	4
	Ins PWR No 1	1	E	6
	Ins Htr No 1	1	E	7
	Area Nav No 1	1	E	8
	Instr XFMR No 2	1	D	9
	CMPS CPLR-1	1	K	24
	Flt Data Rcdr	1	K	26
	Alt Alert-1	1	K	27

		CB Panel No.	Row	Position
ESSENTIAL AC RADIO BUS	Ess Radio Bus Aϕ	3	F	7
	Ess Radio Bus Bϕ	3	F	8
	Ess Radio Bus Cϕ	3	F	9
	HF No 1 AC	1	C	3
	Weather Radar Ind No 1	1	D	2
	Weather Radar Rt No 1	1	D	3
	Radio Altm No 1	1	D	4
	DME No 1	1	D	5
	Voice Rcdr	1	D	1

		CB Panel No.	Row	Position
ESSENTIAL DC BUS	Eng Start PWR	3	F	10
	Flt Recorder DC	3	G	4
	PFCS ADS/DH Ind Lt	3	G	8
	Flt Cont Alt Alert Ind Lt	3	G	9
	Rat Ind Lt	3	G	10
	AC Bus Ind	3	G	11
	ECS Ind Lt	3	G	12
	DC Auto XFR	3	G	13
	Gen Overload Protect	3	G	14
	IDG Disc	3	G	15
	Electric Meter Switch	3	G	16
	Door Warn Lt	3	H	2
	Proximity Switch 2	3	H	3
	Proximity Switch 3	3	H	4
	Air Data Heat Sensors	3	H	5
	Thunderstorm Lt	3	J	2
	Crew Utility Lt	3	J	3
	CTR Console Flood Lights	3	J	4
	Emer Lts Charge Sense	3	J	6
	Stby Lt Relay	3	J	11
	LE Slat extend Lt	3	K	18
	Ovht Loop A Alarm Eng No 1	3	L	1
	Ovht Loop B Alarm Eng No 1	3	L	3
	Ovht Loop A Alarm Eng No 2	3	L	7
	Ovht Loop B Alarm Eng No 2	3	L	9
	Ovht Loop A Alarm Eng No 3	3	L	13
	Ovht Loop B Alarm Eng No 3	3	L	15
	All Eng Cont Ign Sel	3	L	18
	APU Bleed Air Valve	3	S	18
	Eng No 1 Turb Ovht Det A	3	M	1
	Eng No 1 Turb Ovht Det B	3	M	2
	Eng No 1 Turb Ovht Det Ind	3	M	3
	Eng No 2 Turb Ovht Det A	3	M	7
	Eng No 2 Turb Ovht Det B	3	M	8
	Eng No 2 Turb Ovht Det Ind	3	M	9
	Eng No 3 Turb Ovht Det A	3	M	13
	Eng No 3 Turb Ovht Det B	3	M	14
	Eng No 3 Turb Ovht Det Ind	3	M	15
	Speed Cont No 1 Sys AFCS	1	A	2
	Trim Agmt DC No 1 Sys AFCS	1	A	8
	AFCS Mode Ind	1	B	1
	FCES Computers DC	1	B	4
	FCES Stick Shake	1	B	6
	Spoiler Dwell DC AFCS	1	B	7
	Aft Coupler No 1 AFCS	1	B	9
	Alt Source Sel Capt Instr	1	E	1
	Alt Source Sel P/2 Instr	1	E	2
	DC Stby PWR	3	F	1
	DC TlE Bus Cont	3	F	2
	DC TlE Bus PWR	3	F	3

		CB Panel No	Row	Position
ESSENTIAL DC BUS (Cont)	Ess Master Radio PWR	3	F	4
	Master Radio Cont	3	F	5
ESSENTIAL RADIO DC BUS	Ess Radio Bus DC	3	F	6
	HF Comm No 1 DC	1	C	1
	Selcal Comm	1	C	5
	Marker Beacon No 1	1	D	7
	Inst Cmprn Mon PWR No 1	1	D	8
AC STANDBY BUS	Tach N3 Eng No 1	1	E	10
	Tach N3 Eng No 2	1	E	11
	Tach N3 Eng No 3	1	E	12
	TGT Eng 1	1	F	10
	TGT Eng 2	1	F	11
	TGT Eng 3	1	F	12
	B Start Ign Eng 1	1	F	13
	B Start Ign Eng 2	1	F	14
	B Start Ign Eng 3	1	F	15
	Capt IAS/Mach	1	F	1
	Capt ADI	1	F	2
	Capt HSI	1	F	3
	Capt Altm	1	F	4
	Stby Horizon No 1 Ind	1	F	6
	Stby Horizon No 1 Lt	1	F	7
	ATC No 1	1	G	3
	ILS No 1	1	G	4
	Dir Gyro No 1	1	G	5
	VG/Ins-1 No 1	1	G	6
	Cmps Coupler No 1	1	G	7
	Air Data Cmptr No 1	1	G	8
	AC Stby Bus Sense	1	K	10
	Stby Inverter Voltage	1	K	18
	Instr XFMR No 1	1	F	5
	CMPS CPLR-1	1	K	19
	VOR-1	1	K	21

		CB Panel No	Row	Position
DC STANDBY BUS	Stby Compass Light	1	F	8
	Instr Pnl Flood light	1	F	9
	Emer Fuel Shutoff Eng 1	1	F	16
	Emer Fuel Shutoff Eng 2	1	F	17
	Emer Fuel Shutoff Eng 3	1	F	18
	Eng 1 Isln Valve	1	G	10
	Eng 2 Isln Valve	1	G	11
	Eng 3 Isln Valve	1	G	12
	Fus Isln Valve	1	G	16
	Crossbleed Valve L	1	G	17
	Crossbleed Valve R	1	G	18
	VHF DC VOR RCVR No 1 Navigation	1	G	19
	VHF DC Preamp No 1 Navigation	1	G	2
	Cabin Press Manual Control Fwd	1	H	1
	Cabin Press Manual Control Aft	1	H	2
	Pack Flow Control 1	1	H	3
	Pack Flow Control 2	1	H	4
	Pack Flow Control 3	1	H	5
	Pack High Flow Cont	1	H	6
	Thrust Reverse Eng 1	1	H	16
	Thrust Reverse Eng 2	1	H	17
	Thrust Reverse Eng 3	1	H	18
	Master Alarm PWR Eng 1	1	J	1
	Master Alarm PWR Eng 2	1	J	2
	Master Alarm PWR Eng 3	1	J	3
	Whl Well and APU Master Alarm PWR	1	J	4
	Fire Detection Test	1	J	5
	Firebell PWR Fire Detection	1	J	6
	APU Fire Shutdown	1	J	7
	APU Sec Emer Shutoff	1	J	8
	No 2 Asym Bk LE Slat	1	J	10
	No 2 Asym Bk TE Flap	1	J	11
	Lock Light LE Slat	1	J	12
	Lock Light TE Flap	1	J	13
	Air Ovbd	1	J	14
	Pass Oxygen Normal Mask	1	J	15
	Pass Oxygen Normal Gen	1	J	16
	Pass Oxygen Override Mask	1	J	17
	Pass Oxygen Override Gen	1	J	18
	Loop A Alarm Eng 1	1	K	1
	Loop A Alarm Eng 2	1	K	2
	Loop A Alarm Eng 3	1	K	3
	Loop A Alarm APU	1	K	4
	Loop B Alarm Eng 1	1	K	5
	Loop B Alarm Eng 2	1	K	6
	Loop B Alarm Eng 3	1	K	7
	Loop B Alarm APU	1	K	8
	AC Ess Bus Cont	1	K	11
	DC Stby Ind	1	K	13

		CB Panel No	Row	Position
DC STANDBY BUS (Cont)	Emer Unarm Ind	1	K	14
	Gen 1 Control Units	1	K	15
	Gen 2 Control Units	1	K	16
	Gen 3 Control Units	1	K	17
	Rain Repellant Inbd	1	L	1
	Rain Repellant Outb	1	L	2
	Rat Auto Deploy	1	L	3
	Aisle Lights	1	L	5
	Galley and Lav Lights	1	L	4
	Aural Warn Cabin Press and Test	1	L	6
	Aural Warn Ovsp	1	L	7
	Aural Warn Mult SND	1	L	8
	A/C Config	1	L	9
	Prox SW PWR No 1	1	L	10
	Prox SW PWR No 4	1	L	11
	Warn Horn Landing Gear	1	L	12
	Door Posn Ind Landing Gear	1	L	13
	Altn Gear Cont	1	L	14

		CB Panel No	Row	Position
ENGINE START BUS BAR	Start Cont Eng 1	1	E	13
	Start Cont Eng 2	1	E	14
	Start Cont Eng 3	1	E	15
	HP3 Bleed Air Eng 1	1	E	16
	HP3 Bleed Air Eng 2	1	E	17
	HP3 Bleed Air Eng 3	1	E	18
	HI Press Valves Eng 1	1	G	13
	HI Press Valves Eng 2	1	G	14
	HI Press Valves Eng 3	1	G	15
	Eng Start Bus Sense	1	K	12
	Hyd Pump and Firewall Shutoff Valve Cont Sys A	1	L	15
	Sys B	1	L	16
	Sys C	1	L	17
	Sys D	1	L	18
BATTERY BUS BAR	Eng 3 Alt Fire Extinguisher	1	C	15
	APU Main Fire Extinguisher	1	C	16
	APU Alt Fire Extinguisher	1	C	17
	Tank Eng 1 Fuel Shutoff Valve	1	D	10
	Tank Eng 2 Fuel Shutoff Valve	1	D	11
	Tank Eng 3 Fuel Shutoff Valve	1	D	12
	Tank APU Fuel shutoff Valve	1	D	13
	Pri Emer 2 Fuel Shutoff valves	1	D	14
	Pri Emer APU Fuel Shutoff Valves	1	D	15
	Master Alarm PWR APU Fire Det	1	D	18
	APU Fire Shutdown Fire Extinguisher	1	C	18
	Alarm Loop A APU Fire Det	1	D	16
	Alarm Loop B APU Fire Det	1	D	17
	Ess Master Radio Cont	1	B	10
	Standby DC Cont	1	B	12
	Standby DC PWR	1	B	13
	Rat Man Deploy	1	B	14
	Eng Start PWR	1	B	15
	Evac Signal	1	B	17
	Elect Clock System	1	B	18
	Eng 1 Main Fire Extinguisher	1	C	10
	Eng 1 Alt Fire Extinguisher	1	C	11
	Eng 2 Main Fire Extinguisher	1	C	12
	Eng 2 Alt Fire Extinguisher	1	C	13
	Eng 3 Main Fire Extinguisher	1	C	14
	Ess Master Radio PWR	1	B	11
	Audio Control Capt & P3	1	A	12
	Audio Control P2 & OBS	1	A	13
	Flt Inph Ampl	1	A	14
	PA No 1	1	A	15
	PA No 2	1	A	16
	VHF No 1	1	A	11

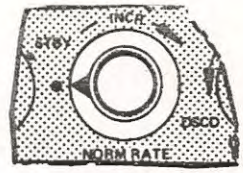
		CB Panel No	Row	Position
BATTERY BUS BAR (OR DC GROUND SERVICE BUS)	APU Fire Horn	3	S	6
	APU Firewall Shutoff Prim	3	S	7
	APU Firewall Shutoff Sec	3	S	8
	APU Inlet Door	3	S	9
	APU Ignition	3	S	11
	APU Cont PWR	3	S	12
	APU Power Control	3	S	13
	APU Ejector and Vent Valve	3	S	15

INTENTIONALLY BLANK

FLIGHT DECK
PANEL SWITCHES

There are basically three types of switches used:-

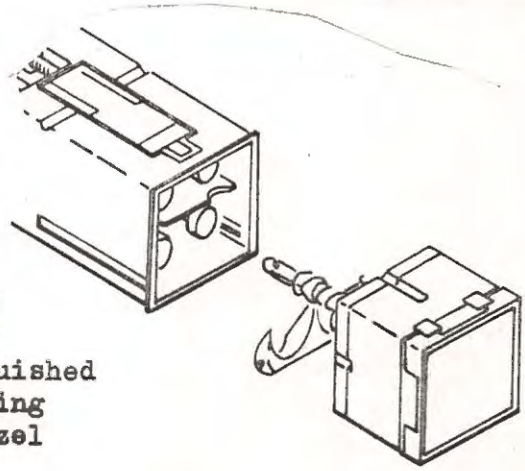
(i) Rotary



(ii) Toggle - SOME MAGNETICALLY HELD. LIFT & SHIFT TYPE.

(iii) Switchlights.

Switchlights

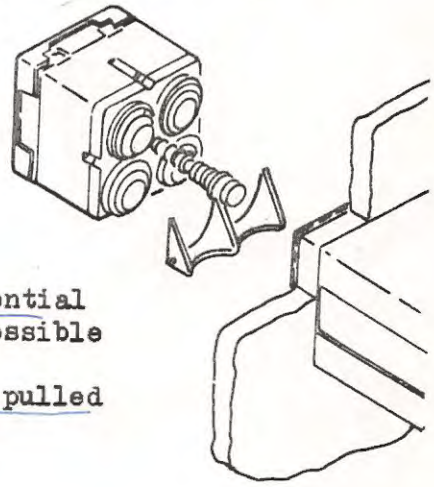


As switchlights predominate on the flight deck panels and their application varies considerably, they will be described in more detail. They can be readily distinguished from a similar indicating light by the chrome bezel surrounding the lens.

LATCH IN FLUSH WITH PANEL.

The assembly consists of a pushbutton switch and lens cap with an illuminated inscription or flowbar. They are either of the momentary or latching type.

Filament Changing

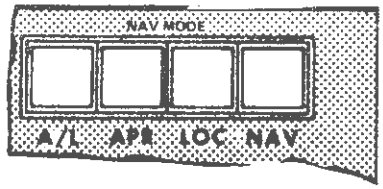


Filaments are changed by pulling out the lens cap assembly with finger nails, then removing suspect filaments from the back.

In some instances it is essential for reasons of safety, or possible damage to systems, that the relevant circuit breaker be pulled prior to filament changing.

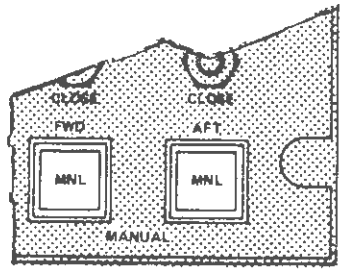
EXAMPLES OF SWITCHLIGHT APPLICATION

The switchlight illustrated are of the momentary type. When pressed the square illuminates in soft white to identify selected mode. There is no inscription. Pressing a second time disengages mode and extinguishes light.



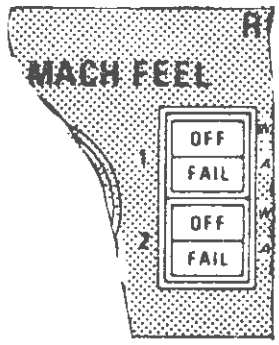
The type illustrated has white letter on an opaque background and can be read when unlatched and extinguished.

When latched in, background illuminates and depending on the system, could be white, red, green or amber.

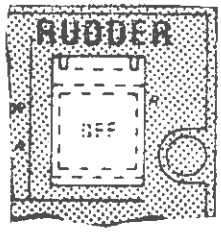


Another type of square switchlight is dark when not in use with a split screen switch that indicates two different conditions.

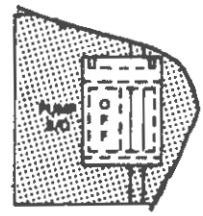
The example illustrated can display an OFF condition, or an abnormal FAIL condition. These inscriptions, although in the same switchlight, are displaying completely separate information.



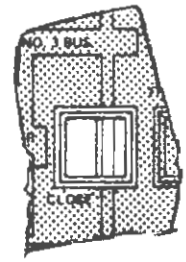
In this example of a switchlight providing a critical display, the switchlight is dark until pressed. The entire switch, including the painted inscription, illuminate red. The increased light area will serve as a reminder that something has been operated.



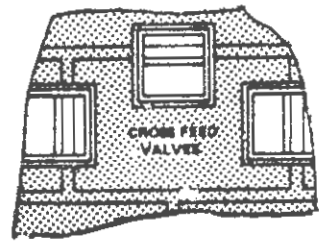
Where is is necessary to complete a panel schematic and indicate the position of a switch, the combined flowbar and inscription switchlight will be used.



The use of a flowbar on its own again can indicate switch, valve, or relay position, depending on the system.

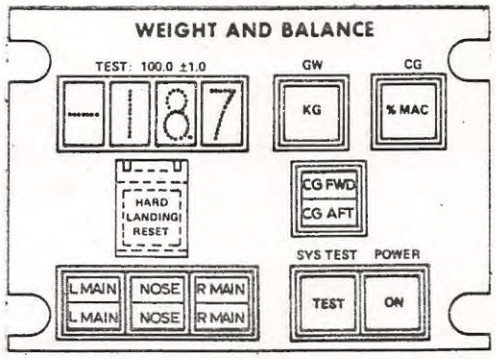


A combination of flowbar and Intransit light. The flowbar indicates switch position. Completion of the panel schematic and the intransit light portion will provide positive indication of valve operation.



WEIGHT AND BALANCE SYSTEM

The weight and balance system measures the aircraft gross weight in kilograms and computes the centre of gravity as a percentage of mean aerodynamic chord (MAC) when the aircraft is on the ground.

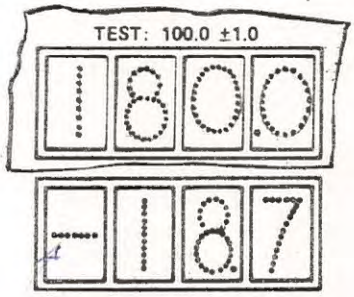


GROSS WEIGHT/ CENTRE OF GRAVITY (GW/CG) DISPLAY WINDOW

Displays either:-

(i) Aircraft gross weight in kilograms times 1000.

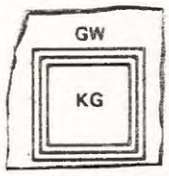
(ii) Mean aerodynamic chord in percentage.



NOT A MINUS SIGN.

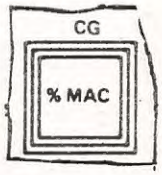
GROSS WEIGHT SELECTOR SWITCHLIGHT

Momentary switchlight which on pressing illuminates and displays aircraft gross weight in display window. Pressing when illuminated extinguishes switchlight and removes gross weight from display window.



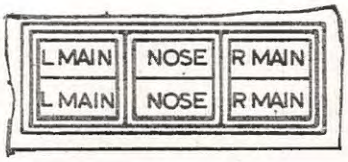
CENTRE OF GRAVITY SELECTOR SWITCHLIGHT

Momentary switchlight which on pressing illuminates and displays aircraft centre of gravity in display window. Pressing when illuminated extinguishes switchlight and removes C of G from display window.



HARD LANDING INDICATORS

Amber will illuminate when associated undercarriage is subject to a minor hard landing, and the Red section a major hard landing. If indicating when power is removed indications will return when power is re-applied.



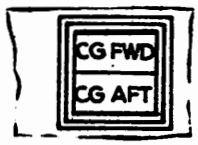
HARD LANDING RESET SWITCHLIGHT

Illuminates simultaneously with any of the above.
Pressing will extinguish the illuminated inscription and any of the hard landing indicators that may be illuminated.

CENTRE OF GRAVITY

C G FWD illuminated
C of G forward of 13%

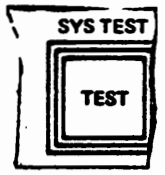
C G AFT illuminated
C of G aft of 34%.



SYSTEM TEST SWITCH

Momentary switchlight that on pressing drives display window to 888.8 and illuminates all indicators and switchlights.
On release SYS TEST switchlight and digital readout indicator remains on and reads 100.0 $\pm$ 1.0.
Pressing a second time, terminates test.

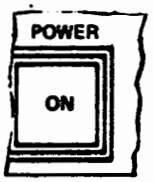
NOTE: Test can also be terminated by pressing either GW or CG switchlight.



POWER SWITCH

IN Switchlight illuminated system powered.

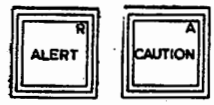
OUT System deactivated.



MASTER WARNING SYSTEM

ALERT AND CAUTION Attention Switchlights

Momentary pushbutton switchlights, one containing a red ALERT inscription the other an amber CAUTION inscription. The lights are not dimmable.



Red ALERT lights flash when any of the red alert display windows on the master warning display panel illuminate. The amber CAUTION attention light flashes at the same rate when any of the amber display windows illuminate.

Momentarily pressing the flashing switchlight extinguishes it and re-arms the circuitry to accept a new warning input.

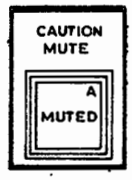
Cancel Switch

Momentary pushbutton switch.

Pressing the switch extinguishes all illuminated red and amber lights on the display panel and rearms the circuitry to accept new warning inputs.

Caution Mute Switchlight

Momentary alternate action pushbutton switch.



Pressing the switch illuminates the amber MUTED inscription and inhibits the amber caution attention lights and all amber display windows.

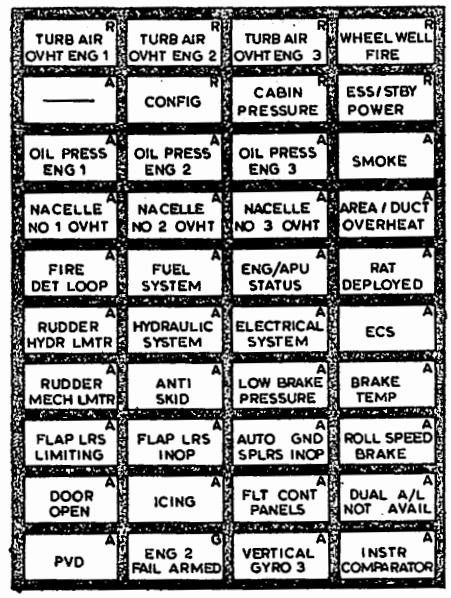
Pressing the switch a second time extinguishes the MUTED inscription and the caution attention and amber display windows are no longer inhibited.

The MUTE function is for use on the ground only.

Master Warning Display Panel

The panel consists of a matrix of display windows which are arranged in two groups. Alert and Caution.

NOTE: The green ENG 2 FAIL ARMED window is not part of the M.W.S. It is normal for this window to be illuminated prior to take off and then to extinguish.

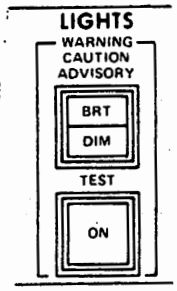


Warning Caution and Advisory Lights Intensity Switch

IN - DIM is illuminated and all amber display windows, warning and advisory lights are dimmed on the P1, Centre Instrument P2 and Roof Panels.

OUT - BRT is illuminated and a full bright illumination is provided.

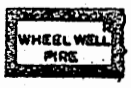
Pilots Overhead Panel

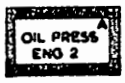
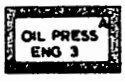
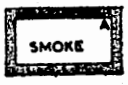
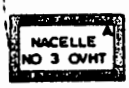


Warning Caution and Advisory Light Test Switch

IN - ON is illuminated. The Alert and Caution attention lights will flash, Alert and Caution display windows warning and advisory lights will illuminate.

OUT - ON is extinguished. All indicator lights revert to the state indicated prior to test. The exceptions to this are the Alert and Caution attention lights which will continue to flash until cancelled, and any display window in which a fault exists. This provides a reinstatement facility for display windows previously cancelled.

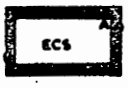
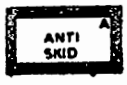
MASTER WARNING DISPLAY	ASSOCIATED SYSTEM IDENTITY AND INDICATION	LOCATION
	ENG TURB COOLING AIR Eng 1 OVHT	Systems Station
	ENG TURB COOLING AIR Eng 2 OVHT	Systems Station
	ENG TURB COOLING AIR Eng 3 OVHT	Systems Station
	CAPT MASTER FIRE LIGHT P.2. MASTER FIRE LIGHT WHEEL WELL FIRE TEST PANEL Wheel well fire detector loop A Wheel well fire detector loop B	Glare shield Glare shield Systems Station
	NONE	
	NONE	
	ELECTRICAL PANEL DC Stby bus FAIL AC stby bus FAIL AC ess bus FAIL DC ess bus FAIL	Systems Station

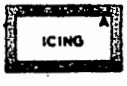
MASTER WARNING DISPLAY	ASSOCIATED SYSTEM IDENTITY AND INDICATION	LOCATION
	Eng No.1. Oil Pressure Gauge	Systems Station
	Eng No.2. Oil Pressure Gauge	
	Eng No.3. Oil Pressure Gauge	
	SMOKE DETECTION PANEL Smoke Detection Cargo FWD A Smoke Detection Cargo FWD B Smoke Detection Cargo CTR A Smoke Detection Cargo CTR B Smoke Detection Cargo AFT A Smoke Detection Cargo AFT B Smoke Detection Galley SYS A SMOKE Smoke Detection Galley SYS B DUCT Smoke Detection FESC B Smoke Detection MESC B	Systems Station
	NACELLE/PYLON OVHT DET TEST PANEL Nac/Pylon Ovht Det A ENG 1 Nac/Pylon Ovht Det B ENG 1	Systems Station
	Nac/Pylon Ovht Det A ENG 2 Nac/Pylon Ovht Det B ENG 2	
	Nac/Pylon Ovht Det A ENG 3 Nac/Pylon Ovht Det B ENG 3	

MASTER WARNING DISPLAY	ASSOCIATED SYSTEM IDENTITY AND INDICATION	LOCATION
	ENGINE BLEED CONTROL PANEL Eng No.1. DUCT OVHT Eng No.2. DUCT OVHT Eng No.3. DUCT OVHT Area A AREA OVHT Area B AREA OVHT Area C AREA OVHT Area D ISLN AREA OVHT Area E ISLN AREA OVHT Area J ISLN AREA OVHT Area H AREA OVHT	Systems Station
	WING ANTI-ICE PANEL Left Duct Fail Right Duct Fail	Overhead Panel
	FUEL AND IGNITION PANEL ENG 1 switch guards ENG 2 switch guards ENG 3 switch guards	Centre Pedestal
	ENGINE NO.1. FIRE PANEL No.1. FIRE PULL Handle	Overhead Panel
	ENGINE NO.2. FIRE PANEL No.2. FIRE PULL Handle	Overhead Panel
	ENGINE NO. 3. FIRE PANEL No.3. FIRE PULL Handle	Overhead Panel
	P1 Master FIRE Light P2 Master FIRE Light	Glareshield
	A.P.U. FIRE PANEL A.P.U. FIRE PULL Handle	Systems Station
	FIRE DETECTION LOOP TEST Fire det loop A ENG 1 Fire det loop B ENG 1 Fire det loop A ENG 2 Fire det loop B ENG 2 Fire det loop A ENG 3 Fire det loop B ENG 3 Fire det loop A APU Fire det loop B APU	Systems Station

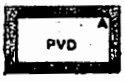
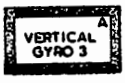
MASTER WARNING DISPLAY	ASSOCIATED SYSTEM IDENTITY AND INDICATION	LOCATION
	FUEL SYSTEM PANEL 2L inbd LOW 2R inbd LOW Tank 2L pumps LOW Tank 2L pumps LOW Tank 1 pumps LOW Tank 1 pumps LOW Tank 3 pumps LOW Tank 3 pumps LOW Tank 2R pumps LOW Tank 2R pumps LOW Eng 1 FUEL PRESSURE Eng 2 FUEL PRESSURE Eng 3 FUEL PRESSURE	Systems Station
	ENGINE STATUS PANEL No.1. Eng vib. caution LT. No.2. Eng vib. caution LT. No.3. Eng vib. caution LT. ENGINE OIL PANEL No.1. Eng FILTER PRESSURE No.2. Eng FILTER PRESSURE No.3. Eng FILTER PRESSURE APU CONTROL PANEL OVERSPEED N2 LOW PRESS OIL HIGH TEMP OIL OVER TEMP TGT	Systems Station Systems Station Systems Station
	HYDRAULIC SYSTEM PANEL Ram air turbine UNLKD	Systems Station
	FLIGHT CONTROLS PANEL Rudder Limited Hydraulic PUSH	Overhead Panel

MASTER WARNING DISPLAY	ASSOCIATED SYSTEM IDENTITY AND INDICATION	LOCATION
	HYDRAULIC SYSTEM PANEL Reservoir LO QTY System A Reservoir HI TEM System A Reservoir LO QTY System B Reservoir HI TEM System B Reservoir LO QTY System C Reservoir HI TEM System C Reservoir LO QTY System D Reservoir HI TEM System D A.T.M. LUBE LO PR System B A.T.M. LUBE HI TEM System B A.T.M. LUBE LO PR System C A.T.M. LUBE HI TEM System C E.D.P. Case drain HI TEM System A E.D.P. Pump out LO PR System A E.D.P. Case drain HI TEM System B E.D.P. Pump out LO PR System B E.D.P. Case drain HI TEM System C E.D.P. Pump out LO PR System C E.D.P. Case drain HI TEM System D E.D.P. Pump out LO PR System D A.T.M. Case drain HI TEM System B A.T.M. Pump out LO PRE System B A.T.M. Case drain HI TEM System C A.T.M. Pump out LO PRE System C	Systems Station
	ELECTRICAL PANEL Eng. No.1. IDG OVHT PRESS Eng. No.2. IDG OVHT PRESS Eng. No.3. IDG OVHT PRESS APU Gen. Oil PRESS APU Gen. Field OPEN Eng. No.1. Gen. Field OPEN Eng. No.2. Gen. Field OPEN Eng. No.3. Gen. Field OPEN No.1. Flt Sta Bus FAIL No.2. Flt Sta Bus FAIL No.3. Flt Sta Bus FAIL No.1. BTB OPEN No.2. BTB OPEN No.3. BTB OPEN Stby pwr ON APU Gen. Oil OVHT	Systems Station

MASTER WARNING DISPLAY	ASSOCIATED SYSTEM IDENTITY AND INDICATION	LOCATION
	ENGINE BLEED CONTROL PANEL Eng No.1. Pack Flow Control OVHT Eng No.2. Pack Flow Control OVHT Eng No.3. Pack Flow Control OVHT No.2. Hot Air Isln Valve OVHT No.3. Hot Air Isln Valve OVHT RAM AUTO Floor Heat FAIL	Systems Station
	CABIN PRESSURE CONTROL Safety Valve FWD OPEN Safety Valve AFT OPEN Cabin Press. Control FAULT Cabin Press. Control FWD Manual Cabin Press. Control AFT Manual	Systems Station
	ECS MONITOR PANEL Cool Air Ovbd CLOSE Avionic Air LOFLO FWD Avionic Air LOFLO MID Cargo Heat HOT FWD Cargo Heat HOT MID Cargo Heat HOT AFT	Systems Station
	FLIGHT CONTROLS PANEL Rudder Limiter Mech. PUSH	Overhead Panel
	ANTI-SKID PANEL Anti-skid OFF	Systems Station
	HYDRAULIC SYSTEM Brake Accum Norm Low Press Brake Accum Alt Low Press	Centre Instrument Panel

MASTER WARNING DISPLAY	ASSOCIATED SYSTEM IDENTITY AND INDICATION	LOCATION
	BRAKE TEMP PANEL Overheat	Systems Station
	NONE	
	FLAP LRS OVRD Flap LRS INOP	Centre Pedestal
	NONE	
	NONE	
	ANNUNCIATOR DISPLAY PANEL L1 ENTRY DOOR FWD CARGO DOOR FWD LOCK FWD CARGO DOOR AFT LOCK R1 ENTRY DOOR GALLEY DOOR L2 ENTRY DOOR CTR CARGO DOOR R2 ENTRY DOOR AVIONICS DOOR L3 ENTRY DOOR AFT CARGO DOOR R3 ENTRY DOOR FWD S-DUCT DOOR L4 ENTRY DOOR ESCAPE HATCH R4 ENTRY DOOR AFT S-DUCT DOOR MAIN ELEC DOOR	Systems Station
	NONE	

MASTER WARNING DISPLAY	ASSOCIATED SYSTEM IDENTITY AND INDICATION	LOCATION
	FCES PANEL Yaw SAS No.1. FAIL Yaw SAS No.2. FAIL DLC Auto Spoiler No.1. FAIL DLC Auto Spoiler No.2. FAIL Stall Warn No.1. FAIL Stall Warn No.2. FAIL A.T.S. No. 1 FAIL A.T.S. No. 2 FAIL Pitch Trim No.1. FAIL Pitch Trim No.2. FAIL Mach Trim No.1. FAIL Mach Trim No.2. FAIL PFCS PANEL Pitch 1 Monitor FAIL Pitch 2 Monitor FAIL Roll 1 Monitor FAIL Roll 2 Monitor FAIL Rudder OFF STABILIZER A INOP STABILIZER B INOP STABILIZER C INOP STABILIZER D INOP STABILIZER A PUSH STABILIZER B PUSH STABILIZER C PUSH STABILIZER D PUSH PULL PITCH DISC AFT CPLR OPEN Aileron L OUTBD Aileron L OUTBD OFF Aileron L INBD Aileron L INBD OFF Aileron L OUTBD OFF Pull Roll DISC Aileron R INBD Aileron R INBD OFF Aileron R OUTBD Aileron R OUTBD OFF Spoiler RL5 & 6 PUSH Spoiler L & R4 PUSH Spoiler L & R2 PUSH Spoiler L & R3 PUSH Spoiler R5 & 6 PUSH Spoiler L5 & 6 OFF Spoiler L8& R4 OFF Spoiler L & R1 OFF Spoiler L & R2 OFF Spoiler L & R3 OFF Spoiler R5 & 6 OFF	Overhead Panel Overhead Panel ALL LOCATED IN ONE AREA, I.E. F.C.E.S & P.F.C.S. PANELS BELOW. No 1 ENG. FIRE HANDLE.

MASTER WARNING DISPLAY	ASSOCIATED SYSTEM IDENTITY AND INDICATION	LOCATION
(Cont'd)	FLT CONTROLS PANEL Mach Feel No.1. FAIL Mach Feel No.2. FAIL Rudder Limiter Mechanical PUSH Rudder Limiter Hydraulic PUSH	Overhead Panel
	NONE	
	NONE	
	NONE	
	INSTRUMENT COMPARATOR INDICATOR AIRSPEED ATTITUDE ALTITUDE HEADING	P1 and P2 Main Instrument Panels

AIR GROUND SENSING SYSTEM

The air/ground sensing system provides control signals which, when fed to certain aircraft systems, will modify system operation. There are three sensors on the undercarriage assemblies, controlling a number of relays.

Nose Undercarriage

The sensor fitted to the nose leg will, on detecting oleo compression, energise a relay modifying the following systems in the manner indicated.

SYSTEM EQUIPMENT	ON GROUND	IN AIR
Nose Wheel Steering	Operative	Inoperative
V.H.F. Anti-ice	Inoperative	Operative
Ram Air Turbine Manual Deployment	Inhibited	Armed
MID and AFT Cargo Door Controls	Available	Inoperative

Main Undercarriage

Either sensors fitted to the main undercarriage oleos will, on detecting compression, energise 9 relays, modifying the following systems in the manner indicated.

AIR/GROUND SENSING SYSTEM

SYSTEM/EQUIPMENT	ON GROUND	IN AIR
Wheel Well Lights	Available	Inoperative
APU Automatic Fire Extinguisher operation	Operative	Available if armed
Passenger Door (L & R1, L & R2, L & R3) electrical controls.	Operative	Inoperative
Ram Air Turbine Auto Deployment	Inhibited	Armed
Wing Anti-ice	Inoperative	Normal
No.1, 2 and 3 Pack Ram Air Exhaust Louvres	Exhaust Louvres Drive Full Open	Exhaust Louvres operated by Pack Temp. Controller
Voice Recorder	Inoperative	Operative
Pressurisation Outflow Valves	Valves drive full open	Outflow valves operated by pressure controller
Flight Data Recorder	Inoperative	Operative
FWD Cargo Door Controls	Available	Inoperative
ENG 2 FAIL Lights	Armed	Inoperative
Cargo Compartment Lighting	Available	Inoperative
Lavatory Jet Pumps FWD and AFT	Operative	Inoperative
External Power Ground Service Mode	Available	Isolated
P.V.D.	Armed	Inhibited unless override switch latched in.

AURAL WARNING

INTRODUCTION

There are a number of electronically and mechanically produced aural warning signals in the Flight Deck for reference purposes:

(i) Sound produced.

(ii) MWS display (if any)

(iii) Conditions necessary to activate warning.

(iv) Methods of silencing.

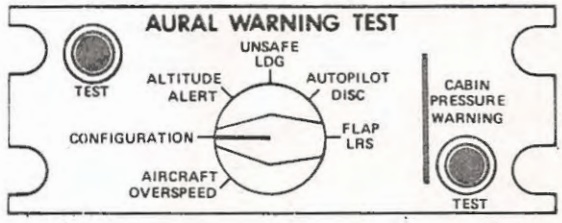
(v) Testing.

will be listed in this section. However a more detailed description will follow when the systems that activate it are covered.

Aural Warning Test Panel

Aural Warning Test Switch.

Momentary switch that tests aural warnings of systems selected by the selector switch.



Aural Warning Test Selector Switch

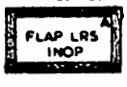
Rotary switch that arms selected system for aural warning test.

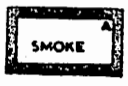
Cabin Pressure Test Switch

Sounds intermittent horn.
That indicates cabin pressure is 12,000 feet or more.

ONLY TONE INJECTED INTO HEAD SET IS "APPROACHING DECISION HEIGHT" WARNING.

WARNINGS SOUND and MWS (if any)	CONDITION TO ACTIVATE WARNING	SILENCING	TESTING
CLACKER	OVERSPEED (aircraft) A/c exceeding Vmo/Mmo		Aural Warn Test Panel at Systems Station
INTERMITTENT HORN CONFIG	IN FLIGHT CONFIGURATION WARNING Sounds under the following conditions:- (a) Airspeed at or below 190 knots plus the slats not fully extended and/ or the flap selector handle between the 0° stop and 4° detent positions. (Warning is inhibited on the ground) (b) Airspeed at or above 250 knots plus the slats not fully retracted and/ or the flap selector handle not at the 0° stop. (c) Speed brake lever in any position beyond the DLC range (17°) plus the flaps not fully retracted and/or the flap selector handle not at the 0° stop. (Warning is inhibited on the ground and at any time following the initial M.L.G. bogie tilt. The warning will be automatically reset in the event of an aborted or go-around landing).	Warnings will sound until condition is corrected.	Aural Warning Test Switch

WARNINGS SOUND and MWS (if any)	CONDITION TO ACTIVATE WARNING	SILENCING	TESTING
INTERMITTENT HORN 	TAKE-OFF CONFIGURATION. Any 2 throttles advanced beyond 50% T.O. thrust position and:- (a) Flaps not within $7\frac{1}{2}^{\circ}$ to 28° range. (b) Pitch trim not within 2.5° to 8.0° band. (c) Speed brake levers not full fwd. (d) Slats not extended.	Warning will sound until the condition is corrected	Aural Warn Test Panel
C-CHORD	ALTITUDE ALERT. At $\pm$ 250 ft. from selected altitude, on approach to, or deviation from (A/P engaged or disengaged)	1-2 second duration	TEST switch on Altitude Select Panel
STEADY HORN	UNSAFE LANDING. Gear not down, locked and:- (a) Flaps extended more than 30°. (b) Airspeed less than 190 kts and any throttle retarded (less than 57°)	Horn cutout on centre console for condition (b) only.	Aural Warn Test Panel.
WAILER	AUTOPILOT DISCONNECT. Disconnect of either A/P channel by any means (Pilot or APFDS logic)	2-second duration Cannot be reset.	Engage and disconnect each Auto-pilot channel.
INTERMITTENT HORN  	FLAPLOAD RELIEVING SYSTEM INOPERATIVE. FLRS de-activated with flaps extended or with flap selection after load relieving system de-activation.	2-second duration (1-time warning)	Aural Warn Test Panel
PULSATING TONE 	CABIN ALTITUDE Excessive cabin altitude (more than 12,000 ft.)	Horn cutout on Cabin Pressure Indicator	Aural Warn Test Panel

WARNINGS SOUND and MWS (if any)	CONDITION TO ACTIVATE WARNING	SILENCING	TESTING
BELL 	ENGINE FIRE OVHT engine accessory area or within core engine.	Bell cutout switch. Fire pull handle. Master Fire lights. OVHT alleviated.	Fire Detection Loop Test Panel
BELL FLT. STA AND HORN IN AFT FUSELAGE 	APU FIRE OVHT in APU compartment.	Bell. Same as for engine fire.	Fire Detection Loop Test Panel.
BELL 	WHEELWELL FIRE OVHT in either main landing gear wheelwell.	Bell cut-out switch. Master fire lights. OVHT alleviated.	Wheelwell Fire Test Panel.
INTERMITTENT HORN 	SMOKE DETECTION Excessive smoke in the forward centre or aft cargo compartments; the forward and mid electronic service centres and in the lower galley. Also when there is excessive heat in the galley oven exhaust duct.	Smoke detection panel TONE CUTOUT switch	Smoke detection panel TEST switch
HEADSET TONE	DECISION HEIGHT. 50 ft. above selected DH on radio altimeter.	DH light on radio altimeter. At DH	Use DH select on radio altimeter.

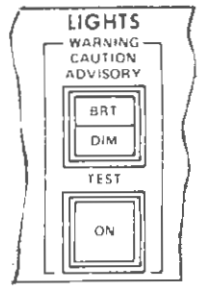
WARNINGS SOUND and MWS (if any)	CONDITION TO ACTIVATE WARNING	SILENCING	TESTING
INTERMITTENT BEEPER	EMERGENCY EVACUATION. Pressing command switch on any evacuation signal panel.	Horn cutout on each Evacuation Signal Panel.	Evacuation Signal Panel Controls.
LO CHIME	CABIN-FLT DECK CALL. Any hostess-to-flight deck call button activation.	Single HI-LO chime per call.	Activate call buttons.
LO CHIME	ENGINEER-FLT. DECK CALL. Activation of GND-TO-CKPT call button.	Single LO chime per call.	Activate GND call button.

SYSTEMS STATION ANNUNCIATOR DISPLAY PANEL

When a specific unit or system sensor detects a fault, the associated display window will be illuminated. The window will remain illuminated until the condition displayed is corrected.

Test switch

ON All display windows of the Annunciator Display Panel, System Station warning and caution lights are illuminated, with the exception of the fire detector and A.P.U. fire bottle discharge lights. Light intensity will be determined by the position of the LIGHTS INTENSITY SWITCH.



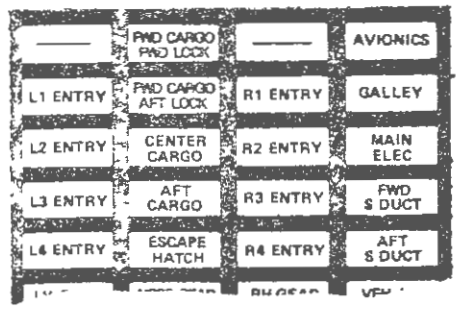
Note:

If the switchlight is left latched in for more than five minutes the test sequence terminates. The TEST switchlight and lights illuminated prior to the TEST switch being operated will remain ON, and all other lights extinguish.

OUT Terminates test at any time.

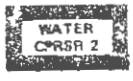
Door Lights

Indicate a specific door or opening is not securely closed.



M.W.S.

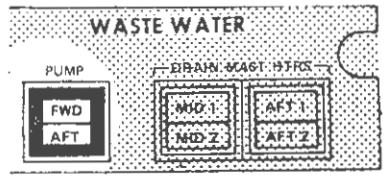
If any door not securely closed.

DISPLAY WINDOW	ASSOCIATED SYSTEM AND INDICATION	LOCATION
	UNDERCARRIAGE Door Warning Light	Centre Instrument Panel
	UNDERCARRIAGE Door Warning Light	Centre Instrument Panel
	UNDERCARRIAGE Door Warning Light	Centre Instrument Panel
	NONE	
	SLAT MONITOR PANEL Slat Segment Lights	Systems Station
	UNDERCARRIAGE Lever Position	Centre Instrument Panel
	ENGINE BLEED CONTROL PANEL Engine Isolation Valve FLOWBAR	Systems Station
	NONE	
	NONE	
	FLAPS Position Indicator	Main Instrument Panel
	NONE	
	NONE	

WASTE WATER PANEL

The appropriate light will illuminate for a pump failure.

Since there are three pumps for each system the other pumps will automatically take over, maintain adequate pressure and extinguish the light.



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INTRODUCTION

The electrical system generates and distributes 117/208V 401 Hz three phase AC and 28 volts DC.

The system can be broken down into the following sub-systems:-

i. AC generation
ii. AC distribution
iii. DC conversion
iv. DC distribution
v. Standby power

Standby Power

The battery and inverter provide emergency standby power to operate those systems essential for the safe operation and landing of the aircraft, in the event of power not being available from normal sources. The battery is also available to start the APU.

Generators

There are four AC generators serving as primary sources of AC power.

One integrated drive generator (IDG) which is a combined CSD and brushless generator is mounted on each engine.

The generator driven by the constant speed APU does not require this feature.

Capacity

Total electrical capacity is such that two generators can comfortably meet the total electrical demand which is likely to be at a maximum under cruise conditions.

Operation

Operation of the electrical system is automatic with the ability to visually monitor and manually control the system at the systems station.

Ground A.C.

An external AC power receptacle is located just aft of the nosewheel.

Equipment Location

The majority of the control equipment is located in the mid electrical service centre which is aft of the galley.

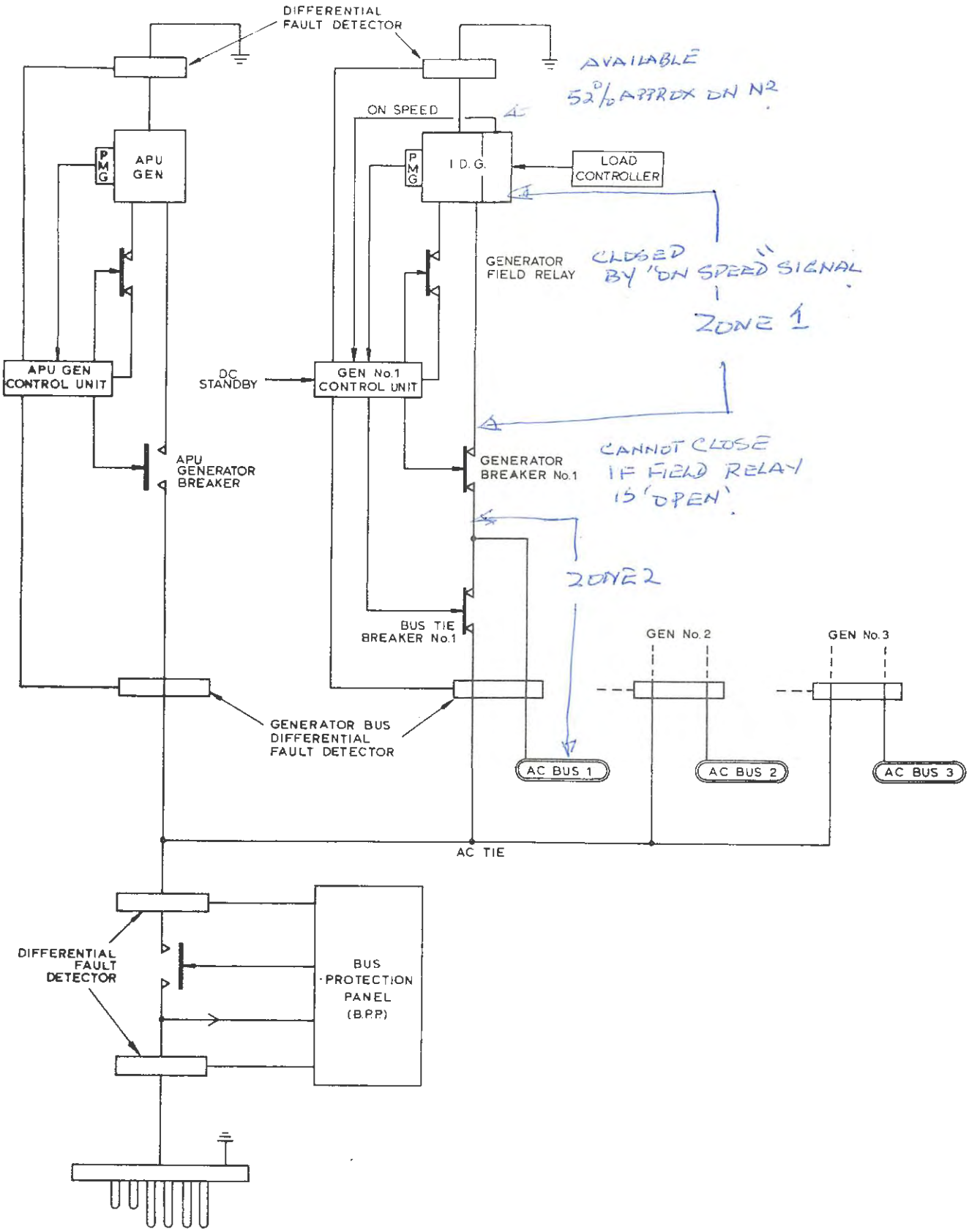
Distribution

Principle areas of distribution are:-

i. Mid electrical service centre.
ii. Forward avionics service centre.
iii. Flight station.

CB Panels

Circuit breaker panels are installed to the rear of the pilots overhead control panels and above the systems station.



AC GENERATION

A.C. GENERATION

90KVA.

All A.C. power is generated by four oil cooled 81KW generators. Three being engine driven through constant speed drives (I.D.G.) the fourth by the A.P.U. All generators are regulated at 117/208 ± 2 volts the frequency being maintained at 401± 4Hz.

The three engine driven generators are normally operated in parallel with the ability to parallel the APU generator with the engine driven generators if desired.

Generator Control

Generator control is under normal conditions completely automatic. The system being monitored by indicators, lights and meters on the electrical section of the systems station. If required, the automatic control can be overridden by control switches to isolate any generator or bus from the system.

Permanent Magnetic Generator

OUTPUT – 125V APPROX

Integral with each main generator is a Permanent Magnetic Generator (P.M.G.) this generator producing an A.C. voltage whenever the main generator is turning. The A.C. voltage produced being utilized to provide excitation and power the generator control unit.

Generator Control Unit

Each generator is monitored and controlled by a generator control unit. (G.C.U.).

The G.C.U. provides a monitor of generator output for:-

i. frequency
ii. voltage
iii. phase rotation
iv. reactive load sharing.

Providing the output is correct the G.C.U. will additionally monitor its associated bus bar for:-

i. frequency
ii. voltage
iii. phase agreement between bus bar and generator output (which is essential for parallel operation of generators).

Fault Detection

Conditions of unsatisfactory generator output, i.e.

i. under frequency
ii. overvoltage
iii. undervoltage
iv. overexcitation
v. Feeder fault

will be detected by the G.C.U. which will respond

cont'd...

by de-energising the generator breaker and in some cases the generator field relay.

Load Controller

A real load controller for each engine driven generator senses the total KW load on its associated generator during parallel operation and ensures the output of the generator is such as to carry its fair share of the real load.

Differential Fault Protection

Differential fault detectors in the generator neutral cables, tie and bus bar feeders are connected to the G.C.U.

If a significant descrepancy is detected between the neutral and feeder currents the G.C.U. will trip the associated generator breaker. If the fault is on the generator side of the G.B. (ZONE I) this will provide sufficient isolation. However if the fault is on the load side of the GB and BTB and sensed by the generator bus differential fault detector. The G.C.U. will respond by de-energising the B.T.B. resulting in complete isolation of the associated bus bar.

Note: After a ZONE 2 fault the B.T.B. can only be reset by removing all DC power.

Current Limiting

To prevent serious overheating occuring in a generator due to an excessive overload and the fault failing to isolate itself.

The G.C.U. will limit the current to 550 amps per phase by suppressing the voltage.

Bus Protection Panel

The Bus Protection Panel B.P.P. fulfils a similar function with regards to the external power source and feeders as the G.C.U. does to the engine driven generators.

It provides a monitor of, and system protection against incorrect:-

i. voltage
ii. frequency
iii. phase rotation

It additionally protects the external power feeders against short circuits, and provides automatic load monitoring should the load on the external source exceed 120 KW.

NORMAL OPERATION

With all AC power sources de-energised the battery switch in the ON position all generator breakers (GB) will be open and all bus tie breakers (B.T.B) will be closed.

External Power

When external power is connected to the external power receptical it is monitored by the Bus Protection Panel (BPP).

380-420Hz. 107-126V MONITOR BEFORE ACCEPTING. →

If satisfactory the AVAIL portion of the EXT PWR ON/AVAIL indicator on the electrical panel will illuminate.

Selecting the EXT PWR switch to the ON position connects external power to the tie bus bar. Since the B.T.B. are closed, power is applied to all bus bars.

NOTE: External power may be applied to the aircraft with the BATTERY switch in the OFF position.

A.P.U. Power

If the A.P.U. is running at governed speed the A.P.U. generator will be available. However the A.P.U. generator breaker (GB) cannot close as long as the EXT PWR is in the ON position.

If the A.P.U. generator is preferred the EXT PWR Switch must be placed in the OFF position.

Engine Starting (Ground AC on line)

If external power is on the AC bus bars during engine starting; when the engine driven generator frequency and voltage are correct the G.C.U:-

i. opens the B.T.B.
ii. closes the G.B.

The effect of this is to transfer the AC bus from external power to its associated engine driven generator.

Until such time as the EXT PWR switch is selected to the OFF position the B.T.B. cannot close and therefore the generators cannot be paralleled.

When the EXT PWR switch is selected OFF a preferential circuit connects the first available generator to the AC bus tie by closing the appropriate Bus Tie Breaker. The remaining generators automatically parallel when their voltage, frequency and phase relationship are satisfactory by closing the appropriate B.T.B.

Engine Starting (A.P.U. on line)

If the A.P.U. is supplying power before engine starting the A.P.U. generator becomes the master generator for automatic paralleling. Engine driven generators paralleling with the A.P.U. when voltage frequency and phase relationship are satisfactory.

Automatic Paralleling

The auto paralleling system senses the voltages on the generator side of the GENERATOR BREAKER and on the Tie Bus Bar.
The voltages are compared for equality, phase relationship and frequency.
When the frequency difference is less than 6Hz and the phase angle less than 90° the G.C.U. closes the applicable GENERATOR BREAKER or BUS TIE BREAKER.
If the EXT PWR switch is in the ON position auto paralleling is inhibited.

Manual Operation

If desired the electrical system can be operated manually.

Pressing momentarily a Generator field TRIP switchlight will result in the opening of the generator field relay. This action automatically

i. De-excites generator
ii. Opens Generator breaker

This removes the generator from its related A.C. bus bar.

Paralleling

A generator may be paralleled by the following sequence. Pressing momentarily

i. Generator field TRIP switchlight (ensures generator is de-excited).
ii. Generator Breaker CLOSE switchlight.
iii. Generator field CLOSE switchlight.

The above sequence is prefered as it utilizes the auto paralleling circuitary which will prevent damage to the I.D.G.

Random Paralleling

If however on completing the above sequence the generator fails to parallel into the system, random paralleling can be attempted by closing:

i. Generator Breaker
OR
ii. Bus tie Breaker

Due to shock loading on the generator drive the above practice would only be undertaken in circumstances laid down in the Flight Management.

Bus Load Monitoring

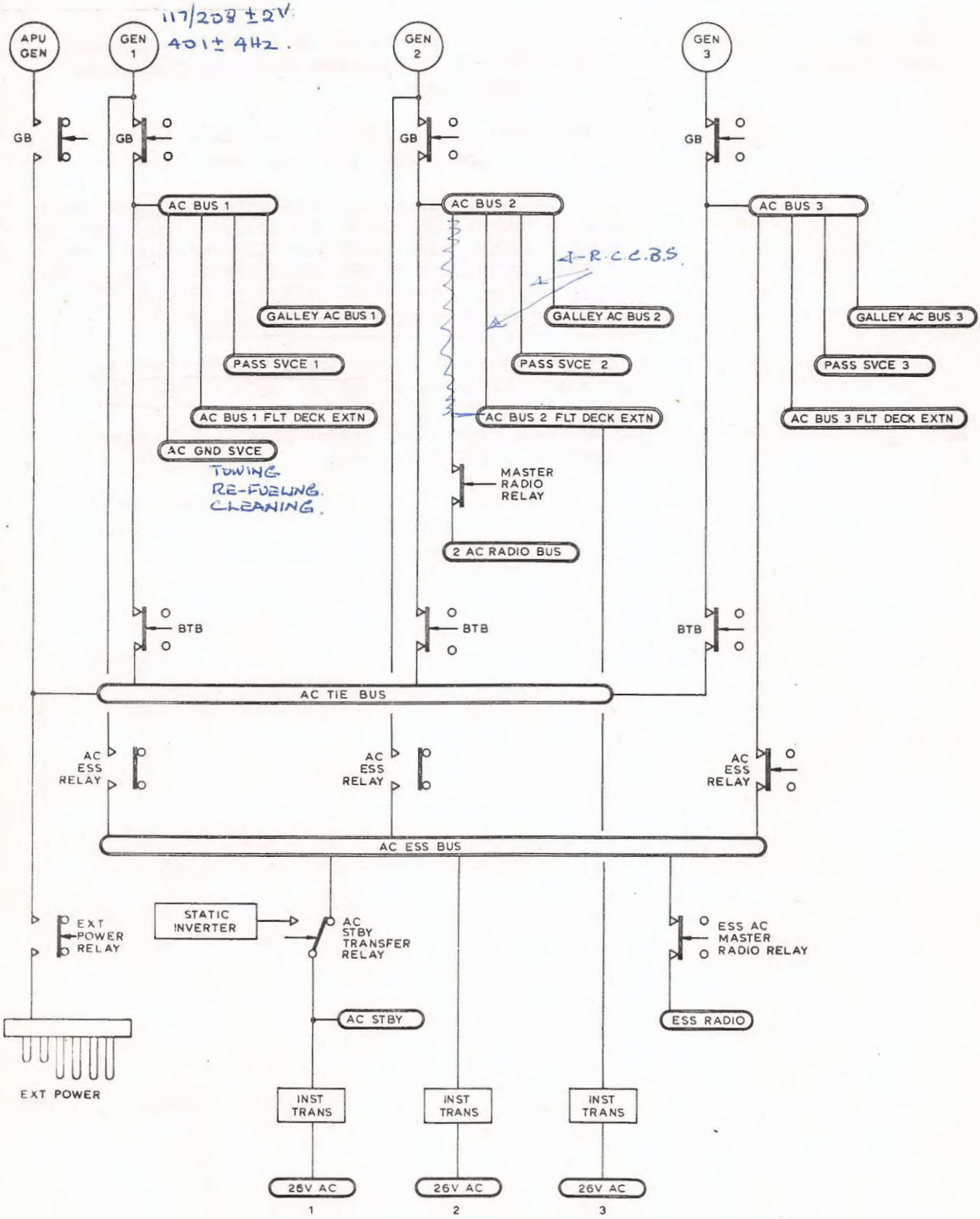
When a load in excess of 120 KW is detected by any generator control unit, or the bus protection panel power is removed from:

i Hydraulic system B & C , A.C. pumps
ii No. 1, 2 and 3 galley AC Bus bars.

These loads will remain isolated until positive reset action is taken. To regain the AC hydraulic pumps all control switches must be in the OFF position. This includes in addition to the switchlights at the system station the switches on the Hydraulic Service Panel located in the hydraulic Service centre.

To regain galley power all three GALLEY POWER switch lights must be released out and before resetting.

The hydraulic pumps and galley power can be reset independently of each other.



AC DISTRIBUTION

A.C. DISTRIBUTION

The distribution of a.c. power is achieved through bus bars located in:

i. mid electrical service centre
ii. galley area
iii. flight station

The following table contains a more detailed list of the bus bars located in each area.

MID ELECTRICAL SERVICE CENTRE	GALLEY AREA	FLIGHT STATION BUSBARS.
MAIN AC BUSES 1, 2, 3 TIE BUS BAR	GALLEY AC BUS 1, 2, 3, PASSENGER SERVICE BUSES 1L 2L 3L 1R 2R 3R	AC BUS EXTENSIONS 1, 2, 3 AC ESSENTIAL RADIO ESSENTIAL No. 2 RADIO AC. AC STANDBY AC GROUND SERVICE

A.C. BUSES 1,2,3

Each bus is powered primarily from its associated engine driven generator or alternatively through the tie bus from any other operating generator or from an external A.C. source.

A.C. TIE BUS

The tie bus provides a means of paralleling the three engine driven and A.P.U. generators.

A.C. Bus 1,2, and 3 EXTENSIONS. FLT DECK EXTNS.

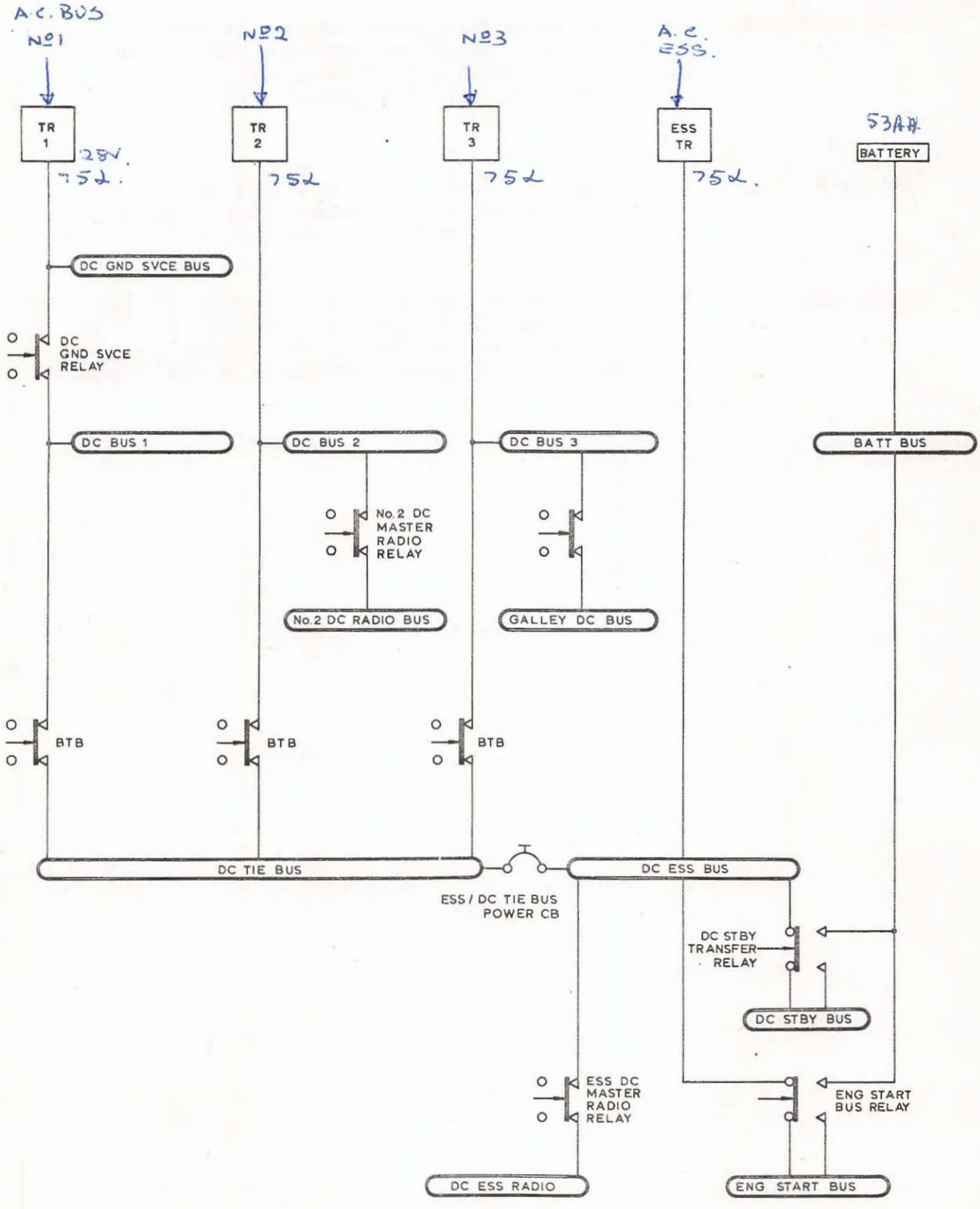
Distribute power to the flight station circuit breaker panels. They are connected to their respective AC buses via remote controlled circuit breakers. (RCCB).

If an AC Extension bus fails, the respective FLT STA BUS FAIL light will illuminate on the electrical control panel, it will remain illuminated until such time as the bus is re-powered. There will in addition be a warning on the Master Warning System.

Cont'd/...

Galley AC Buses 1, 2 and 3	Distribute power from their respective main AC buses through RCCB to the galley left circuit breaker panel. They are controlled by their associated GALLEY POWER switch lights on the electrical control panel.
Passenger Service Buses	Distribute power from their respective main AC Buses through RCCB to the galley left and right C.B. panels.
No. 2 A.C. Radio bus	Powered from No.2 Flt.station bus extension through No.2 Master Radio Relay. The relay being controlled by the No.2 MASTER RADIO switch light located on the pilots overhead panel.
AC Ground Service Bus	Supplies power to a selected number of loads either from external power or the A.P.U. generator without the necessity of powering the complete electrical system. The bus is normally powered whenever No.1 AC bus is powered.
AC Essential	The AC essential bus powers selected essential loads which require three phase AC. The bus is normally connected to No.3 AC bus bar but is automatically or manually transferable to other sources. These being determined by the position of the AC ESSENTIAL BUS selector switch.
AC Standby Bus	The AC standby bus is normally powered from a single phase of the AC essential bus. The AC standby bus may be transferred to the static inverter either manually or automatically. This being dependent on the positions of the standby power switch and battery switch.
Radio Essential	Powered from AC Essential through C.B. and A.C. master radio relay.
Instrument Transformers	The three instrument transformers are powered from:- i AC Standby bus ii AC Essential iii No.2 Flight Station Ext bus They provide 26 volts AC for instrument and navigation systems.

D.C. GENERATION	D.C. power is normally supplied by four 75 ampere transformer rectifier units. Each T.R.U. receiving three phase A.C. and converting it to a nominal 28 volts D.C.
Capacity	Total D.C. load; which in flight is likely to be at its maximum during approach and land is less than the capacity of two T.R.U.'s.
Operation	Operation of the system is automatic, the four T.R.U.'s being normally operated in parallel. But if desired non parallel operation can be achieved by de-latching the DC BUS ISOLATION switchlight on the electrical panel.



DC DISTRIBUTION

DC DISTRIBUTION	The system consists of:- DC BUSES 1, 2 and 3. DC Ground Service Bus. DC bus tie No.2 DC Radio Bus Engine Start Bus DC Essential DC Essential Radio Essential communication Standby bus Battery bus.
D.C. Buses 1,2,& 3	Powered from T.R.U.'s 1, 2 and 3 respectively to power circuits originating in the flight station. Power is isolated from the bus bars when in the ground service mode of operation.
DC Ground Service Bus	Powered directly from No.1 T.R.U. distributes power to a limited number of flight deck and galley circuits.
DC Tie Bus	Provides a means of paralleling DC buses 1, 2 and 3, and the DC essential bus, through operation of the bus tie breakers. This ensures power to the four buses when any or all T.R.U. are operative. The three DC tie breakers which are connected in parallel are powered whenever the DC BUS ISOLATION switch light is latched in its normal position.
No.2 DC Radio Bus	Connected to No.2 DC bus via a relay to power HF and VHF communications.
Engine Start Bus	Powers circuits which are necessary for engine starting normally connected to DC essential but in the event of a DC essential failure will revert to the battery bus as a source of power.
D.C. Essential	Powered directly from essential T.R.U. Connected to the D.C. bus tie via a circuit breaker. This ensures a source of D.C. power whenever any T.R.U. is operating provided the D.C. bus tie breakers are closed.
D.C. Essential Radio Bus	Powered from D.C. Essential. Can be powered from Battery Bus.
Essential Communications Bus	Normally powered from D.C. Essential, under certain conditions can be powered from the battery bus.
Standby Bus	Normally powered from D.C. essential. If D.C. essential fails it would be transferred to the Battery Bus.

Battery Bus	Is connected to the battery at all times. It provides power to start and control the A.P.U, supply an alternate source of power for refuelling and feed critical circuits.

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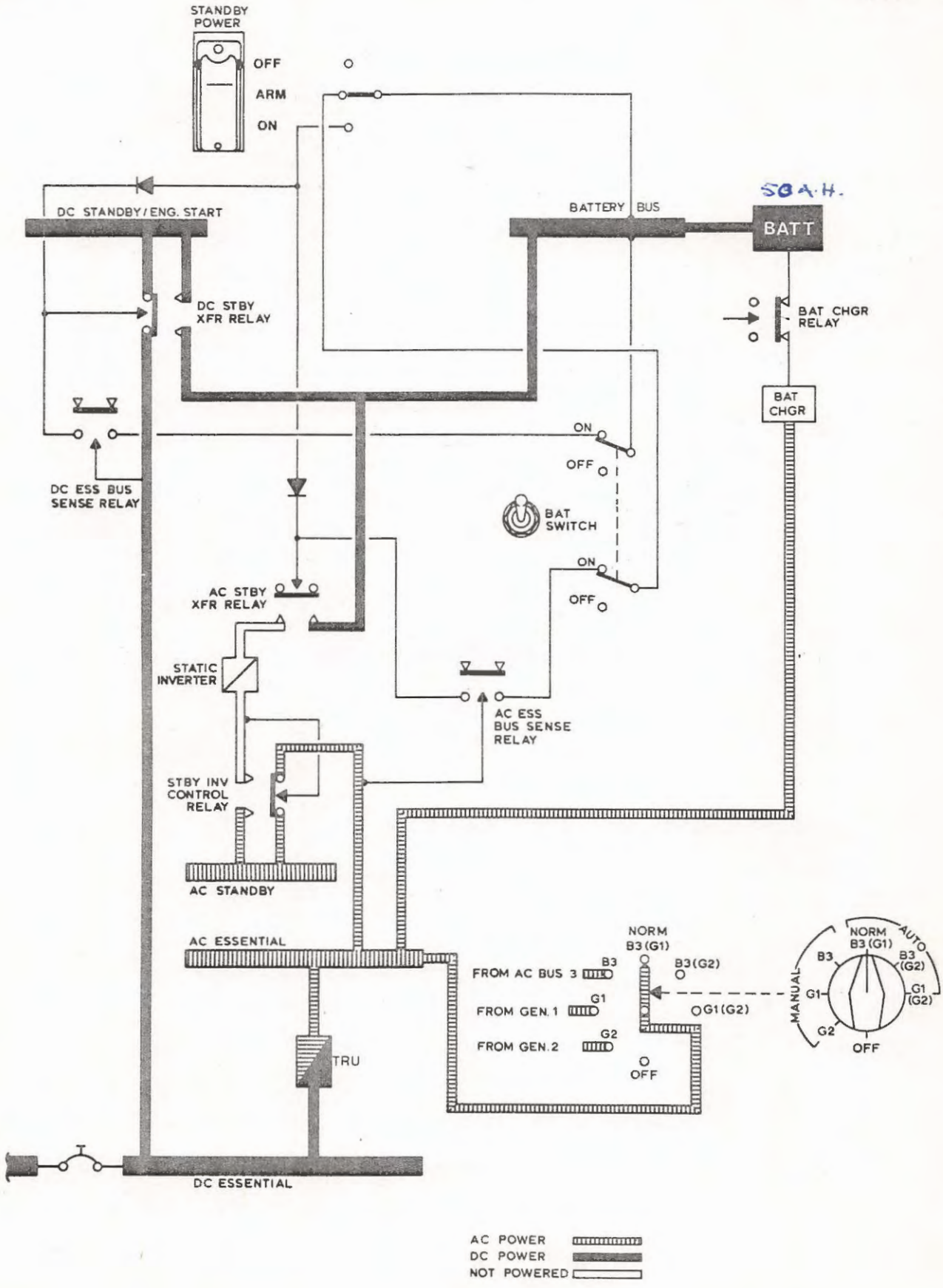

NORMAL, ESSENTIAL AND STANDBY POWER OPERATION
(ESSENTIAL, STANDBY AC/DC POWERED NORMALLY)

STANDBY POWER SYSTEM

The standby power system provides power for a minimum period of 40 minutes to operate essential loads whenever power is not available from normal sources. The system is independent of the main power system. The system includes:

i aircraft battery
ii static inverter
iii standby power switch
iv battery switch

Battery

26V
22 CELL
50 A.H.

The basis of the standby power system is a 50 ampere hour nickel cadmium battery. This battery is used to start the A.P.U. and power the DC portion of the standby power system when normal D.C. sources are not available.

A battery charger powered from the A.C. essential bus bar senses battery voltage and temperature these factors being utilized to determine charge current and therefore maintain the battery in a fully charged state. The charger output is substantially higher than normal battery voltage therefore whenever the battery is to be used as a source of standby power the charger is automatically disconnected.

IN EXCESS OF 90% CAP.
PULSE CHARGED.

40 MINS DURATION
ALL GENY POWER FAILED.

Battery Condition

The light is located on the A.P.U. Control Panel. It indicates a battery overtemperature or shorted cell. These conditions are most likely to occur during A.P.U. starting, hence its location.

CONTROL.

Control of the standby power system is provided by a guarded STANDBY POWER INST & RADIO switch located on the eyebrow panel and the BATTERY switch. System status being indicated by a light adjacent to the guarded switch and lights on the electrical control panel.

OPERATION

The three position switch would normally be selected to the ARM position in flight.

When the switch is placed in the OFF position automatic transfer of the AC Standby bus is prevented.

Whenever the BATTERY or the STANDBY POWER switch is in the OFF position the UNARM light illuminates to indicate that the automatic transfer system is inoperative.

Placing the STANDBY POWER switch to the ON position connects the static inverter and DC Standby bus to the battery bus bar.
A.C. standby bus being transfered from AC essential to the output of the static inverter.

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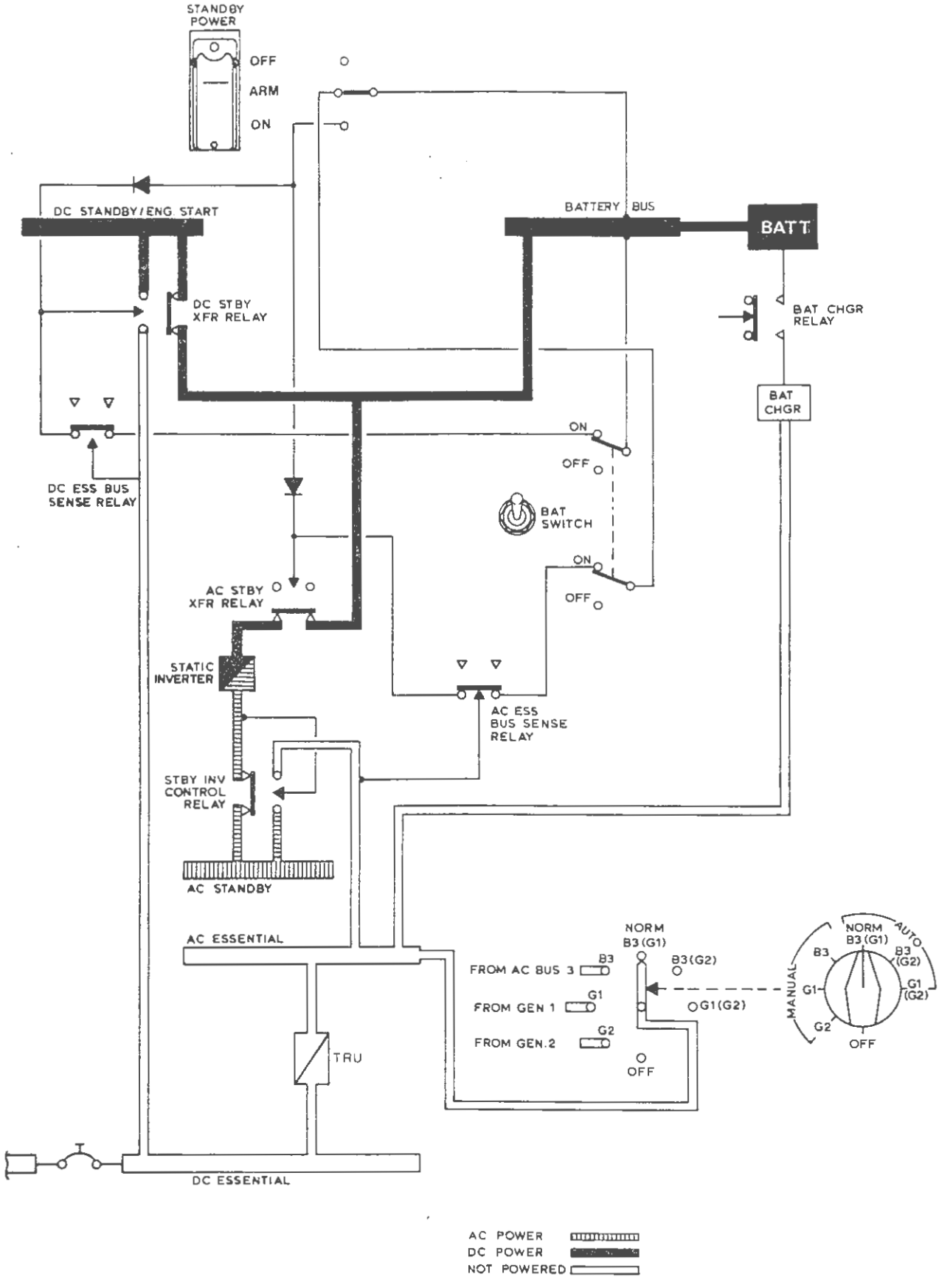


EMERGENCY STANDBY POWER OPERATION
(ESSENTIAL AC/DC FAILED - STANDBY AC/DC POWERED BY BATTERY)

Selecting the battery switch to the OFF position disables the automatic transfer circuit. The standby power UNARM light would illuminate providing there is power on the DC standby bus.

For operation of the automatic transfer system the BATTERY switch must be ON and the STANDBY POWER switch selected to the ARM position.

CONTROLS AND INDICATIONS

IDG OIL TEMPERATURE RISE SWITCH

When switch is pushed, indicator shows temperature rise between IDG oil inlet and outlet. See Electrics 22.

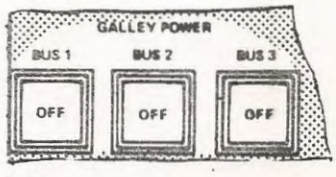
GALLEY POWER SWITCHES

IN - Connect respective main AC bus power to the galley and ovens. OFF is illuminated when the respective galley bus circuit breaker has tripped. Illumination of three OFF lights indicates an overloaded generator or emergency switch operation in galley.

IN EXCESS OF 120 KW

To restore galley power after a generator overload, all three switchlights must be released before resetting.

OUT -Galley and oven power is isolated and OFF is illuminated.



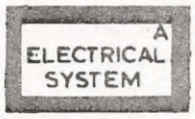
APU GENERATOR OIL LOW PRESSURE LIGHTS

Illuminated PRESS indicates APU generator adapter oil pressure is below minimum limit.

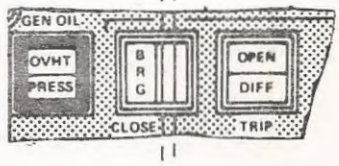
OVERHEAT

Illuminated OVHT indicates APU generator adapter is above max limit.

MWS caution



If OVHT or PRESS illuminated



GENERATOR FIELD RELAY CLOSE SWITCH

A momentary switch that closes a tripped generator field relay. Illuminated flow-bar indicates the generator field relay is closed. Illuminated BRG indicates excessive wear of the generator main bearing.

IF BRG ILLUMINATED. USE — (1) 4 HRS ON LOAD (2) 10 " OFF "

GENERATOR FIELD TRIP SWITCH

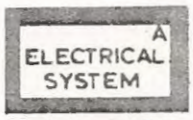
A momentary switch that opens the generator field relay if closed and inhibits the auto-close function.

OPEN is illuminated when field relay has been tripped manually or automatically. (Pulling FIRE PULL handle also trips field relay).

APU " " OPEN SWIT DOES NOT SHOW WHEN A.P. MASTER SW IS "OFF"

DIFF is illuminated when a differential fault exists.

MWS caution

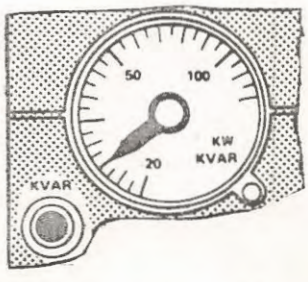


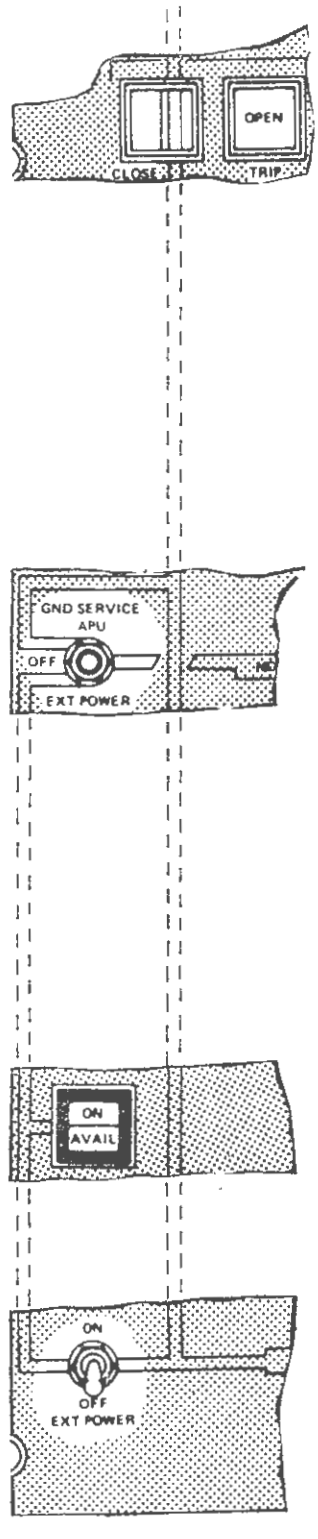
if OPEN illuminated

POWER METER AND KVAR SWITCH

Meter indicates generator load in kilowatts. Under normal parallel operation each meter would indicate approximately the same load.

When KVAR switch is pressed meter indicates kilovolt amp reactance. Normal KVAR is approximately 50% of KW indications.





GENERATOR BREAKER CLOSE SWITCH

A momentary switch that removes an electrical lock and closes a tripped generator breaker if the generator field relay is closed.

Flowbar illuminates when generator breaker is closed.

GENERATOR BREAKER TRIP SWITCH

A momentary switch that opens the generator breaker and inhibits the auto close function. OPEN is illuminated when generator breaker has been tripped manually or automatically.

GROUND SERVICE SELECTOR SWITCH

Permits selecting APU or external power to energise ground service busses. The switch will not latch in either the APU or external power positions if the external power switch is ON.

APU - Connects APU power to ground service busses only.

OFF - Ground service busses are powered normally.

EXT POWER - Connects external power to ground service busses only.

EXTERNAL POWER ON LIGHT

ON is illuminated when external power is used on aircraft.

EXTERNAL POWER AVAIL LIGHT

AVAIL is illuminated when external power is connected and voltage, frequency and phase sequence are correct.

EXTERNAL POWER SWITCH

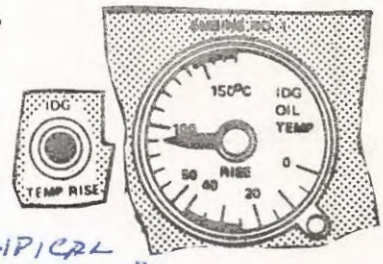
ON - Connects external power to A.C. tie bus. Overrides ground service switch, opens APU generator breaker and removes any other power from A.C. tie bus.

OFF -Disconnects external power from A.C. tie bus.

IDG OIL TEMPERATURE INDICATOR AND TEMP RISE SWITCH

NORMAL RISE 10°C.

Normally indicates IDG outlet temperature, with an amber range extending from 145 to 180°C. On pressing the IDG Temp Rise switch all three gauges will show the difference between the oil temperature at the inlet and outlet points. The temperature indicated will reflect IDG cooling and electrical loads.



TYPICAL 80-90°C.

IDG DISCONNECT SWITCH

A momentary switch that disconnects the IDG.

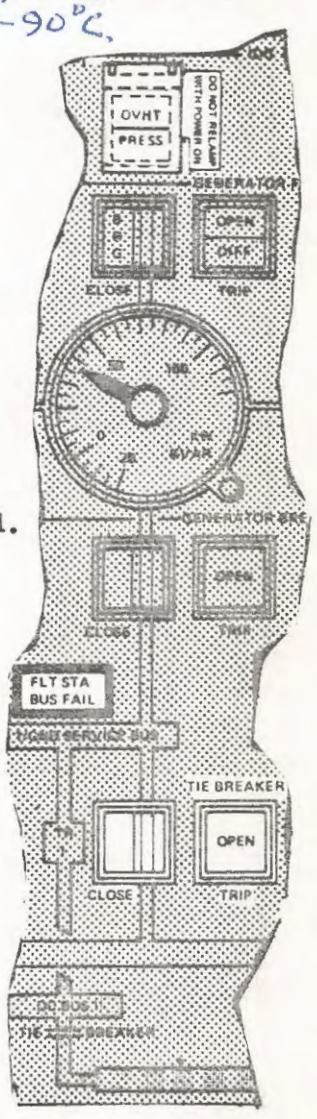
OVHT illuminates when the IDG temperature rises in excess of 145°C.

PRESS illuminates when IDG oil pressure is below minimum.

MWS caution

A ELECTRICAL SYSTEM

if OVHT or PRESS illuminated



FLIGHT STATION AC BUS FAILURE LIGHT

Light is illuminated when the respective A.C. bus extension in the flight station has failed.

MWS caution

A ELECTRICAL SYSTEM

BUS TIE BREAKER CLOSE SWITCH

A momentary switch that removes an electrical lock and immediately closes a tripped bus tie breaker unless a parallel would result between generator and external power. Flowbar illuminates when bus tie breaker is closed.

BUS TIE BREAKER TRIP SWITCH

A momentary switch that opens the bus tie breaker and inhibits the auto close function.

OPEN is illuminated when bus tie has been tripped manually or automatically.

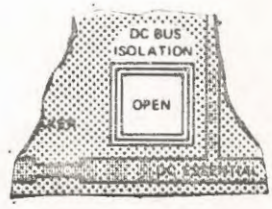
MWS caution

A ELECTRICAL SYSTEM

DC BUS ISOLATION SWITCH

OUT - Connects DC Bus 1, 2 and 3 to the DC tie bus by closing all three tie breakers.

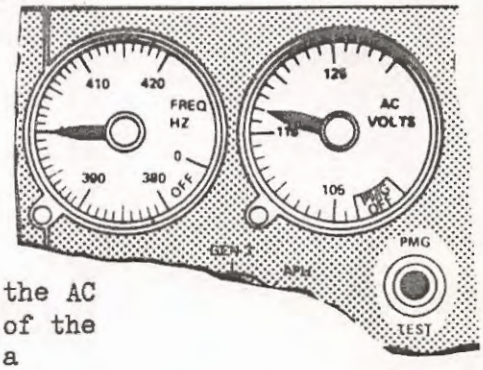
IN - OPEN is illuminated when the DC tie breakers are open and DC busses 1, 2 and 3 are isolated from the DC tie bus.



AC AND DC MONITOR

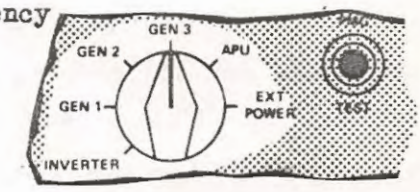
AC FREQUENCY METER — Indicates frequency for position selected. Under normal conditions would indicate 400 ± 4HZ. If the voltage is too low for accurate measurement the meter will indicate OFF.

AC VOLTMETER — Meter indicates AC voltage for selected position. Under normal conditions would indicate 117 ± 2 volts. When needle is in the sector marked PMG OFF generator is stationary.



PMG TEST SWITCH — When the PMG test switch is pressed the AC meter will indicate the PMG voltage of the selected generator. This would be a nominal 125 volts with a minimum of 115 volts.

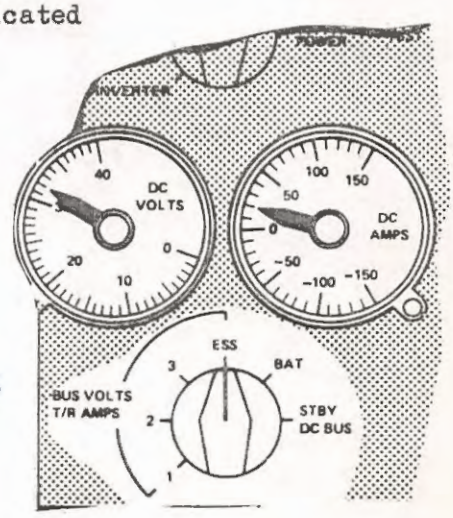
AC METER SELECTOR — Selects AC source of power for AC frequency and volt meters.



DC VOLTMETER — Indicates DC bus voltage for position selected.

DC AMMETER — Indicates TRU or battery amperage for position selected No amperage is indicated for STBY DC BUS position. Battery charging gives a pulsating negative reading.

DC METER SELECTOR — Selects DC source of power for DC volts and amp meters. Amperage is not indicated in the STBY DC BUS position.

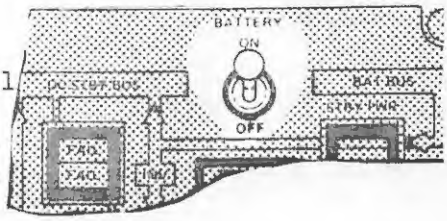


BATT SELECTED — V/M 30V APPROX NORMAL, CAN BE AS MUCH AS 38V.

BATTERY SWITCH

ON - If DC essential bus fails, battery automatically powers DC standby bus. If AC essential bus fails, and standby power switch is in ARM, battery automatically powers AC standby bus through inverter.

OFF - Disarms automatic transfer of AC and DC standby busses to battery bus.



DC STANDBY BUS FAIL LIGHT

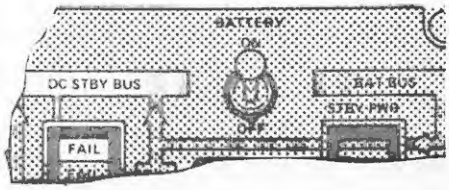
FAIL is illuminated when DC standby bus has failed.

MWS Alert

ESS/STBY POWER R

STANDBY POWER INDICATOR LIGHT

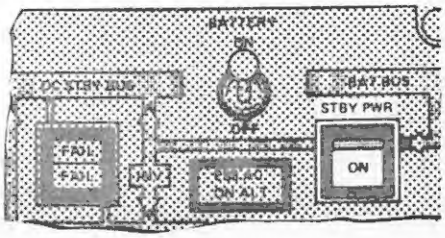
Indicates conditions under which the AC and D C standby busses are powered.



ON and flowbar are not illuminated when the standby busses are powered normally.

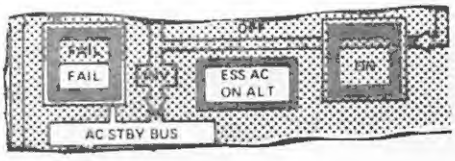
ON is illuminated when the AC and/or DC standby busses have automatically transferred to the battery bus.

Flowbar is illuminated when the battery has been manually selected by the standby power switch to power both the AC and DC standby busses.



ESSENTIAL AC BUS ON ALTERNATE LIGHT

Is illuminated if primary source of power to the AC essential bus has failed and automatic transfer to the alternate power source has occurred.



AC STANDBY BUS FAIL LIGHT

FAIL is illuminated when AC standby bus has failed

MWS Alert

ESS/STBY POWER R

AC ESSENTIAL BUS FAIL LIGHT

FAIL is illuminated when AC essential bus has failed.

MWS Alert

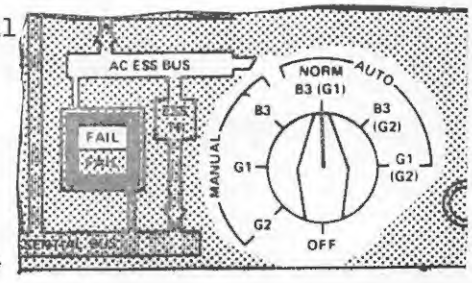
ESS/STBY POWER R

AC ESSENTIAL BUS POWER SELECTOR SWITCH

OFF - De-energises AC essential bus.

MANUAL - Generator 2, generator 1 or AC bus 3 provides a single power source.

AUTO - If the primary source fails the alternate source (in paranthesis) will automatically power the AC essential bus.

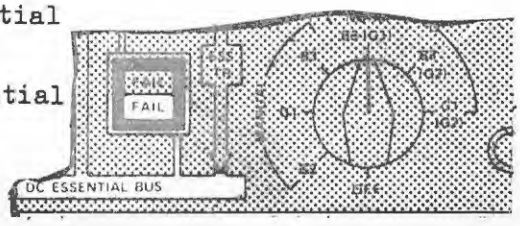


DC ESSENTIAL BUS FAIL LIGHT

FAIL is illuminated when DC essential bus has failed

MWS Alert

ESS/STBY POWER R

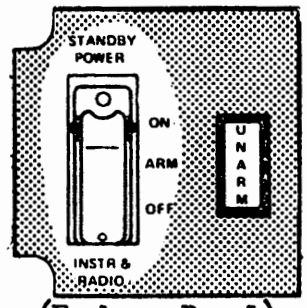


STANDBY POWER SWITCH

ON - Manually connects DC standby bus. Energises the static inverter to power the AC standby bus regardless of battery switch position.

ARM - Permits automatic control of static inverter to energise A C STANDBY bus in the event of it failing. Battery switch must be on.

OFF - Disarms automatic system for AC standby bus only.



(Eyebrow Panel)

UNARM LIGHT

Illuminated when battery switch is OFF or when standby power switch is OFF provided DC standby bus is energised.

FORWARD ATTENDANT'S GROUND SERVICE SWITCHES

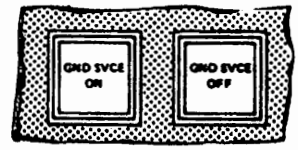
Momentary switches that control ground service power.

Switches inhibited if external power switch is ON or the ground service switch is in the APU position.

Pressing ON illuminates GRD SVCE ON This indicates ground service power is on and controlled at the forward steward's station.

The OFF switch is armed and if the ground service switch at the systems station is in the EXT PWR position it will automatically revert to OFF.

Pressing OFF when armed turns off ground service power and extinguishes the GND SVCE ON light.



(Forward Steward's Panel)

Galley Power
EMER OFF
Switch

IN - EMER OFF illuminates.

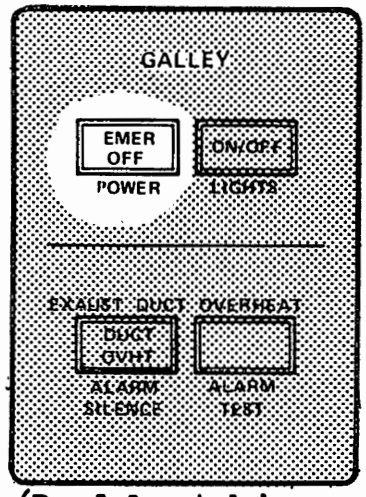
Power removed from galley ovens and bus bars.

All three GALLEY POWER OFF lights (Systems Station) illuminate.

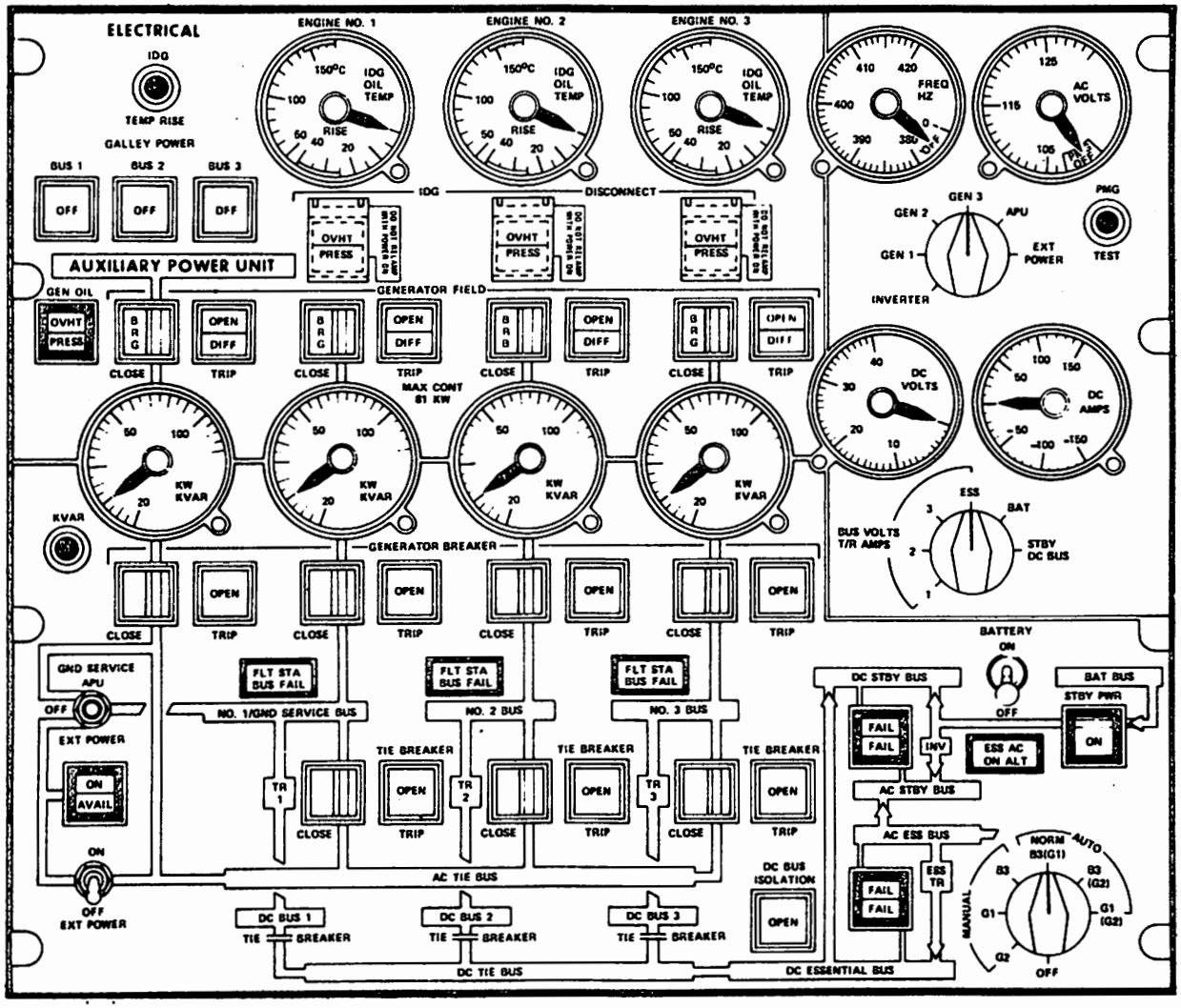
OUT - EMER OFF extinguished.

Power restored to galley ovens and bus bars.

GALLEY POWER OFF lights extinguished.



(Panel located in galley)



ELECTRICAL PANEL

INTENTIONALLY BLANK

AIRCRAFT LIGHTING

Aircraft Lighting comprises the following areas :-

Flight station lighting
Cargo and service compartment lighting
Exterior lighting
Passenger cabin lighting
Emergency lighting

FLIGHT STATION LIGHTING

Lights located in the flight station are :-

Captain's and P2's instrument and glareshield integral lights.

P3's instrument lights.

Overhead lighting.

Thunderstorm light.

Captain's and P2's instrument panel floodlight.

Centre instrument panel floodlight.

Centre console floodlight.

P3's floodlight.

Captain's and P2's instrument panel edge lighting.

Captain's and P2's side console edge lighting.

Centre console edge lighting.

Overhead and eyebrow panel edge lighting.

P3's panel edge lighting.

Forward and aft circuit breaker panel lighting.

Utility lighting

CARGO AND SERVICE COMPARTMENT LIGHTING

Cargo and service compartment lighting includes the forward, mid and aft cargo compartments, and service compartments. Automatic and manual switching is used to control these lights.

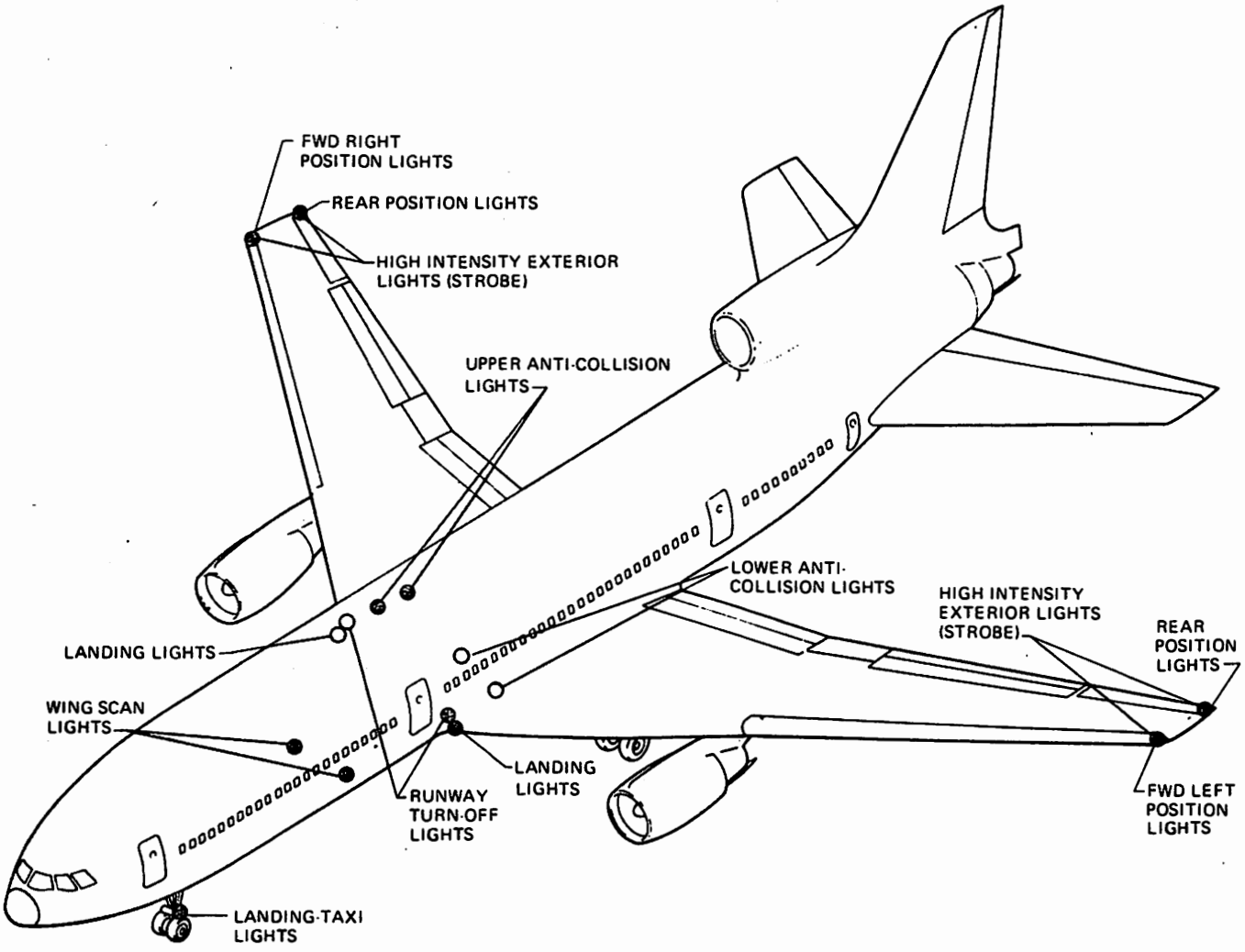
PASSENGER CABIN LIGHTING

Illumination of the passenger cabin is provided by a combination of incandescent and fluorescent lights. General illumination lights are provided for :-
Entrance areas
Vestibules
Storage areas

In addition there are :-
Soffit,
Aisle,
Luminaire,
Passenger reading,
Side wall, and
Sign lights.

Controls for dimming all the lights and turning them on and off, except the reading lights, are located on the left forward and aft stewards panels.

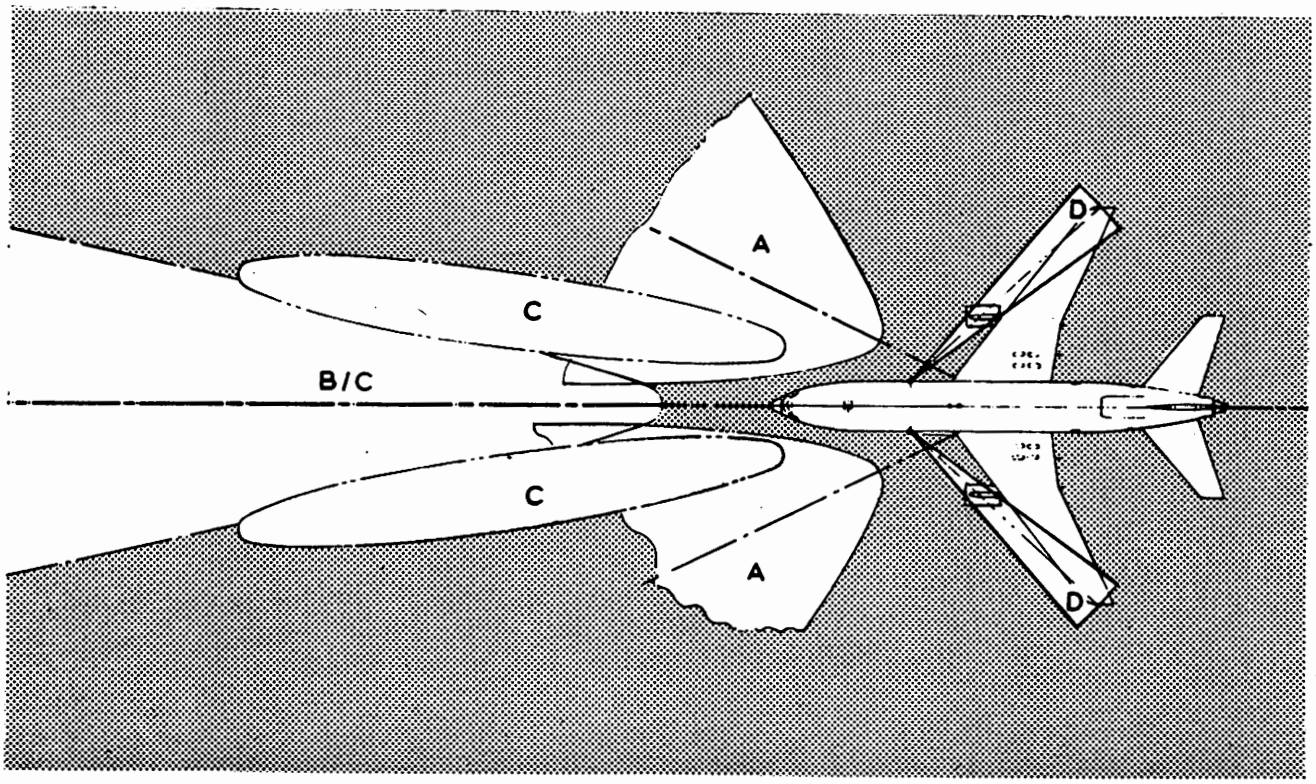
EXTERNAL LIGHTING



EXTERNAL LIGHTING

The aircraft external lighting includes:-

i. Landing lights (C)
ii. Taxi lights (B)
iii. Runway turn off lights (A)
iv. Wing leading edge illumination (D)



In addition there are Strobe, Anti collision, Wheel bay lights and Position lights.

EMERGENCY LIGHTING

The emergency lighting system consists of 10 independent power packs. Each pack consisting of a nickel cadmium battery, automatic battery charger and power failure monitoring circuits. The packs provide emergency power for the :-

Flight station.

Aisle lights.

Aisle exit signs.

Emergency evacuation slide lights.

Galley loading door.

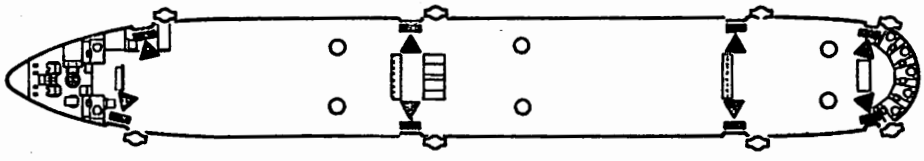
Galley lifts.

Lift shaft lights.

The batteries are automatically kept in a fully charged state by power from the AC Essential bus.

Emergency lighting is controlled by a guarded three position switch.
With the EMERGENCY LIGHTING switch in the ARM position, the DC ESSENTIAL BUS is monitored by each of the emergency power packs. If circumstances occur where DC ESSENTIAL power is lost, the power packs will automatically switch on the Emergency Lighting.

The Emergency Lights can be manually turned on by placing the EMERGENCY LIGHTING switch to the ON position or by the EMERG switchlight on one of the stewards panels.



● FLIGHT DECK OVERHEAD

▬ EXIT SIGN SELF-LUMINOUS

⬡ FLUSH MOUNTED EXTERIOR FLOOD LIGHT

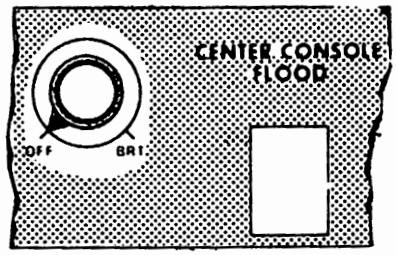
○ AISLEWAY LIGHT

△ EXIT LOCATOR SIGN COMBINED WITH PASSAGEWAY LIGHT

CENTER CONSOLE FLOOD, INSTRUMENT STANDBY AND EMERGENCY LIGHTING CONTROLS

CENTER CONSOLE FLOOD LIGHT SWITCH

Controls light intensity, from OFF to BRT, of the centre console flood light. Light is emitted through a slot in the panel.



INSTRUMENT STANDBY LIGHTS INTENSITY SWITCH

Controls light intensity, dim or bright, of standby lights for the Captain's and P2's instrument panels. The lights are powered automatically from the DC standby bus with loss of DC essential bus.

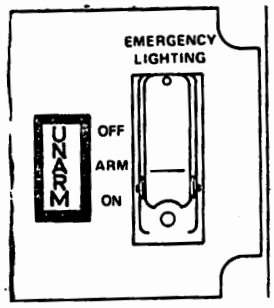
FLIGHT STATION EMERGENCY LIGHTING SWITCH AND UNARM LIGHT

Controls emergency lighting for flight station escape hatch and cabin exit signs, cabin aisle lights, galley and emergency evacuation slide areas.

ON - All emergency lights are illuminated

ARM - Emergency lights are armed to illuminate automatically if DC essential bus fails. UNARM light is illuminated anytime switch is not in ARM and DC standby bus is energised.

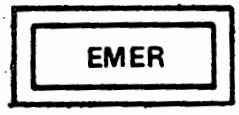
OFF - Disarms the automatic function of all emergency lights.



(Eyebrow Panel)

FLIGHT ATTENDANTS' EMERGENCY LIGHTING SWITCH

A momentary switch which controls emergency lighting for flight station escape hatch and cabin exit signs, cabin aisle lights, galley and emergency evacuation slide areas. When actuated, all emergency lights are illuminated regardless of EMERGENCY LIGHTING switch position in the flight station. Lights may be turned off only by cycling the flight station switch from its present position of ARM or OFF to the opposite position then returning it to its original position.



(Forward & Aft Stewards Panels)

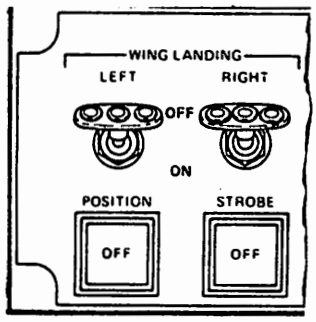
EXTERIOR LIGHT CONTROLS

LANDING LIGHT SWITCHES Controls left and right landing lights mounted in wing fillet leading edges.

POSITION LIGHTS SWITCH Controls forward and rear position lights mounted on wing tips.

IN - OFF is extinguished and position lights are powered

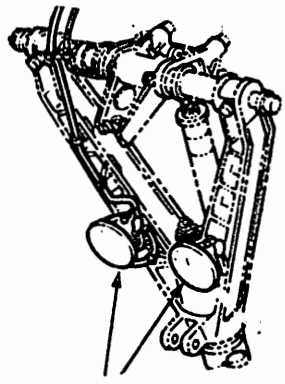
OUT - OFF is illuminated and position lights are de-energised.



STROBE LIGHTS SWITCH Controls forward and aft strobe lights, mounted on each wing tip.

IN - OFF is extinguished and strobe lights are powered.

OUT - OFF is illuminated and strobe lights are de-energised.



landing/taxi lights

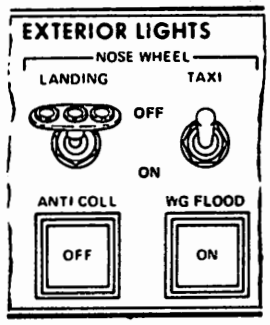
NOSEWHEEL LANDING LIGHT SWITCH ON - Powers high intensity filaments in both light assemblies.

NOSEWHEEL TAXI LIGHT SWITCH ON - Powers low intensity filaments in both light assemblies

ANTI-COLLISION LIGHTS SWITCH Controls rotating lights on top and bottom of fuselage.

IN - OFF is extinguished and anti-collision lights are powered.

OUT - OFF is illuminated and anti-collision lights are de-energised.



WING FLOOD LIGHTS SWITCH Controls fuselage mounted lights to illuminate wing leading edges and engine inlets.

IN - ON is illuminated and wing flood lights are powered.

OUT - ON is extinguished and wing flood lights are de-energised.

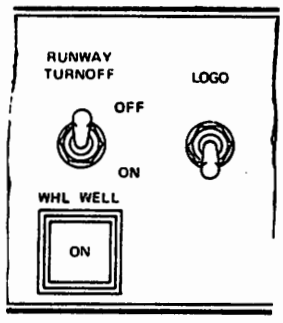
RUNWAY TURNOFF LIGHTS SWITCH Controls lights in fuselage wing fillet leading edge.

LOGOLIGHTS SWITCH Controls Logo lights

WHEEL WELL LIGHTS SWITCH Controls wheel well lights

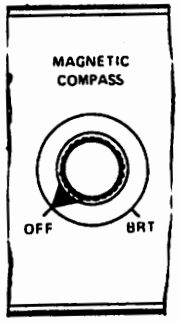
IN - ON is illuminated and wheel well lights are powered

OUT - ON is extinguished and wheel well lights are de-energised.



INTERIOR LIGHT CONTROLS

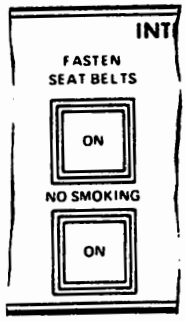
MAGNETIC COMPASS LIGHT SWITCH — Controls brilliance of magnetic compass lighting



FASTEN SEAT BELT SIGN SWITCH

IN - ON is illuminated, single chime sounds and cabin FASTEN SEAT BELT and lavatory RETURN TO SEAT signs are illuminated.

OUT - ON is extinguished, single chime sounds and cabin and lavatory sign lights are extinguished.



NO SMOKING SIGN SWITCH

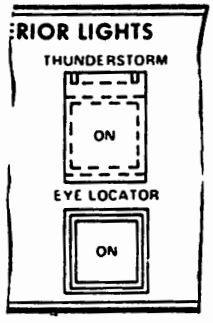
IN - ON is illuminated, single chime sounds and cabin NO SMOKING signs are illuminated.

OUT - ON is extinguished, single chime sounds and cabin NO SMOKING signs are extinguished.

THUNDERSTORM LIGHT SWITCH

IN - ON is illuminated and all dimmable flight station lights are illuminated to maximum brilliance regardless of dimming control position.

OUT - ON is extinguished and all flight station lights are controlled by respective dimming control.

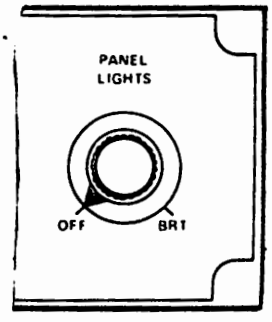


EYE LOCATOR LIGHT SWITCH

IN - ON is illuminated and pilot's eye position locator is powered.

OUT - ON is extinguished and pilot's eye position locator is de-energised.

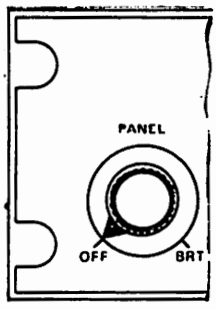
EYEBROW PANEL LIGHT SWITCH — Controls brilliance of eyebrow panel lighting.



PILOT'S LIGHT CONTROLS

PANEL BACK LIGHTING CONTROL

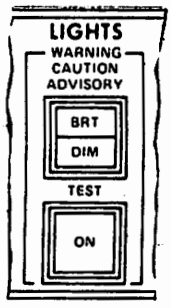
Controls intensity of the pilot's overhead panel back lighting.



WARNING CAUTION AND ADVISORY LIGHTS INTENSITY SWITCH

IN - DIM is illuminated and all amber display windows, warning and advisory lights are dimmed on the P1, Centre Instrument, P2 and Roof Panels.

OUT -BRT is illuminated and a full bright illumination is provided.



(Pilot's Overhead Panel)

WARNING CAUTION AND ADVISORY LIGHTS TEST SWITCH

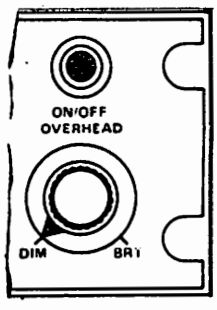
IN - ON is illuminated. The Alert and Caution attention lights will flash. Alert and Caution display windows, warning and advisory lights will illuminate.

OUT -ON is extinguished. All indicator lights revert to the state indicated prior to the test. The exceptions to this are the Alert and Caution attention lights which will continue to flash until cancelled, and any display window in whch a fault exists. This provides a reinstatement facility for display windows previously cancelled.

FLIGHT DECK CEILING LIGHT SWITCH

An alternate action switch that controls the lights located in the flight deck ceiling.

A similar type switch located just inside the flight deck door also controls these lights.

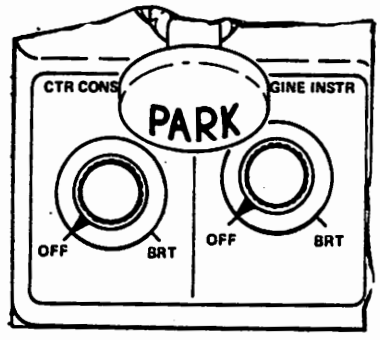


FLIGHT DECK CEILING LIGHT INTENSITY SWITCH

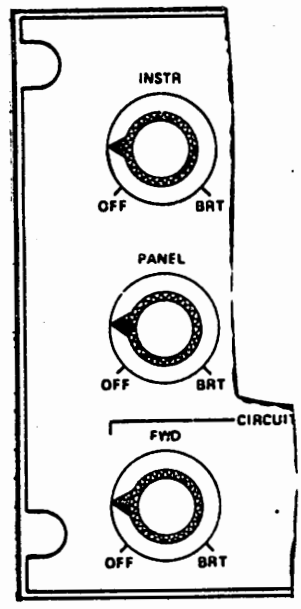
Controls intensity from DIM to BRT of overhead lights.

PILOT'S LIGHT CONTROLS cont'd

CENTRE CONSOLE LIGHTS INTENSITY SWITCH	Controls intensity of the centre console panel back lighting.
PILOT'S ENGINE INSTRUMENT LIGHT INTENSITY SWITCH	Controls intensity of integral lighting of instruments and panel back lighting.



SYSTEMS STATION LIGHT CONTROLS



INSTRUMENT AND SIDE PANEL INTEGRAL LIGHTS

Controls illumination from OFF to BRT of Systems Station panel instrument integral lights.

PANEL AND SCHEMATIC BACK LIGHTING

Controls illumination intensity from OFF to BRT of the system schematic lines and panel legends.

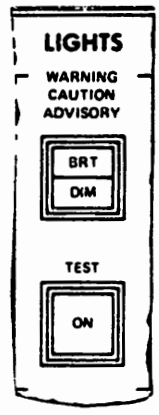
PILOT'S CIRCUIT BREAKER PANEL LIGHTS

Controls panel back lighting from OFF to BRT.

WARNING CAUTION AND ANNUNCIATOR DISPLAY LIGHTS INTENSITY SWITCH

IN - DIM is illuminated and all warning, caution and advisory lights on systems station panels are dimmed.

OUT -BRT is illuminated and full bright illumination is provided.

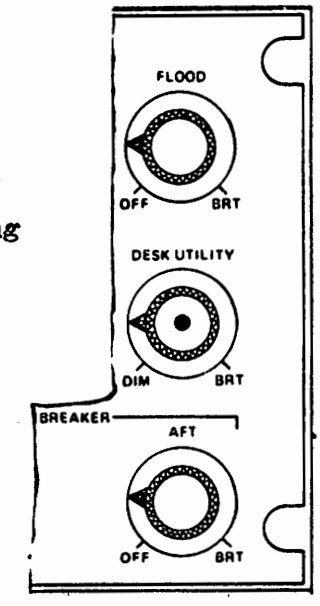


WARNING CAUTION AND ANNUNCIATOR DISPLAY LIGHTS TEST SWITCH

ON - All display windows of the Annunciator Display Panel, Systems Station warning and caution lights are illuminated, with the exception of the fire detector and A.P.U. fire bottle discharge lights. Light intensity will be determined by the position of the LIGHTS INTENSITY SWITCH.

Note:-If the switchlight is left latched in for more than five minutes the test sequence terminates. The TEST switchlight and lights illuminated prior to the TEST switch being operated will remain ON, and all other lights extinguish.

OUT- Terminates test at any time.



UPPER AND LOWER PANEL FLOOD LIGHT

Controls Systems Station flood light above upper panel.

DESK UTILITY LIGHT

Alternate action push switch in knob centre turns light ON or OFF. Rotating knob adjusts brightness.

OVERHEAD AND AFT CIRCUIT BREAKER PANEL LIGHTS

Controls panel back lighting.

MISCELLANEOUS LIGHT CONTROLS

GLARESHIELD PANEL LIGHT CONTROL

Controls glareshield panel backlighting intensity from OFF to BRT.

CAPTAIN'S UTILITY LIGHT CONTROL

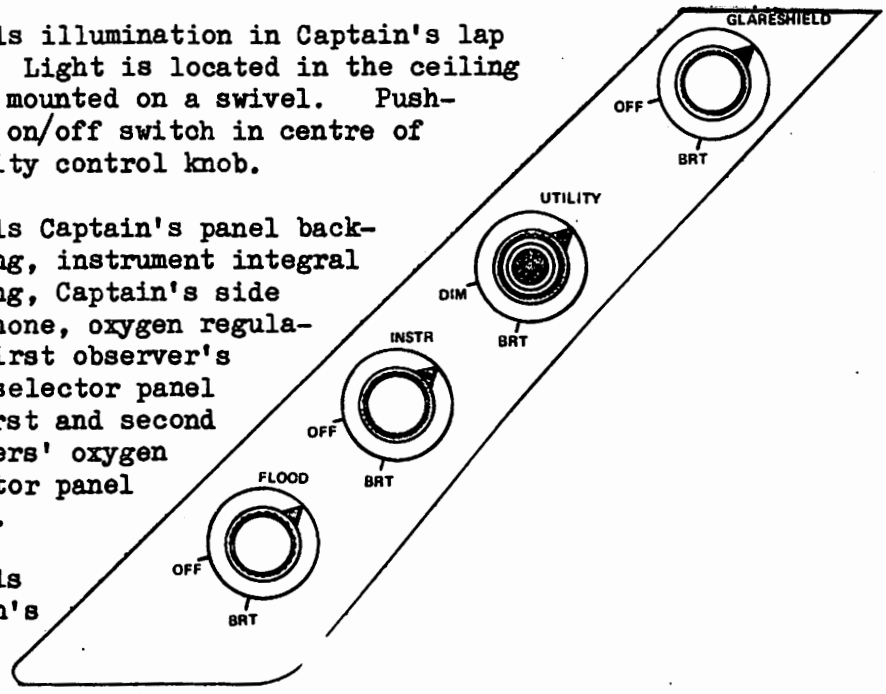
Controls illumination in Captain's lap area. Light is located in the ceiling and is mounted on a swivel. Push-button on/off switch in centre of intensity control knob.

CAPTAIN'S INSTRUMENT PANEL CONTROL

Controls Captain's panel back-lighting, instrument integral lighting, Captain's side interphone, oxygen regulator, first observer's audio selector panel and first and second observers' oxygen regulator panel lights.

CAPTAIN'S AND CENTRE INST PANEL FLOODLIGHT CONTROL

Controls Captain's and centre instrument panel lighting intensity.



P2's UTILITY LIGHT CONTROL

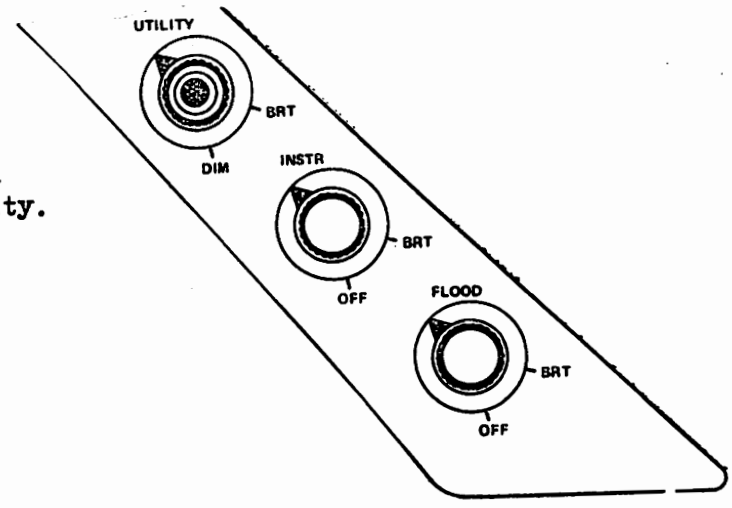
Controls illumination in P2's lap area.

P2's INSTRUMENT PANEL CONTROL

Controls P2's panel back lighting and instrument integral lighting. Also controls P2's side interphone and oxygen regulator panel lights.

P2's INST. PANEL FLOODLIGHT CONTROL

Controls P2's instrument panel lighting intensity.

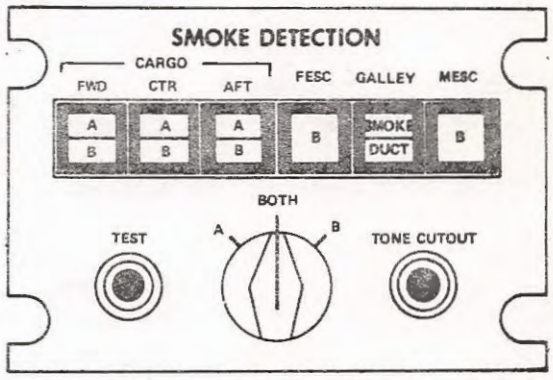


SMOKE DETECTION

Introduction

Each of the three cargo compartments is protected by two smoke detectors, one forward and the other aft. The galley, mid electrical service centre and avionics compartments are each protected by one smoke detector.

To provide a warning of an overheat in the galley oven exhaust ducting a flamestat is installed in the duct.



Detector Indicator Lights

A or B detector lights illuminate to indicate smoke in the respective compartment or satisfactory test when the TEST pushbutton is pushed in.

Detector TEST Pushbutton

IN - Detector selector at BOTH.
Three A and five B detector lights illuminate and intermittent horn sounds.

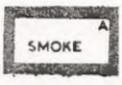
Detector selector at A or B.
A or B detector lights illuminate as selected.

GALLEY SMOKE illuminates.

Note:- Detector TEST pushbutton does not check GALLEY DUCT overheat light. (CHECKED ON GALLEY PANEL).

Detector Selector Rotary Switch

BOTH - Normal position.
A or B detectors will activate M.W.S.



A - Inhibits cargo compartments B, FESC and MESC detectors.

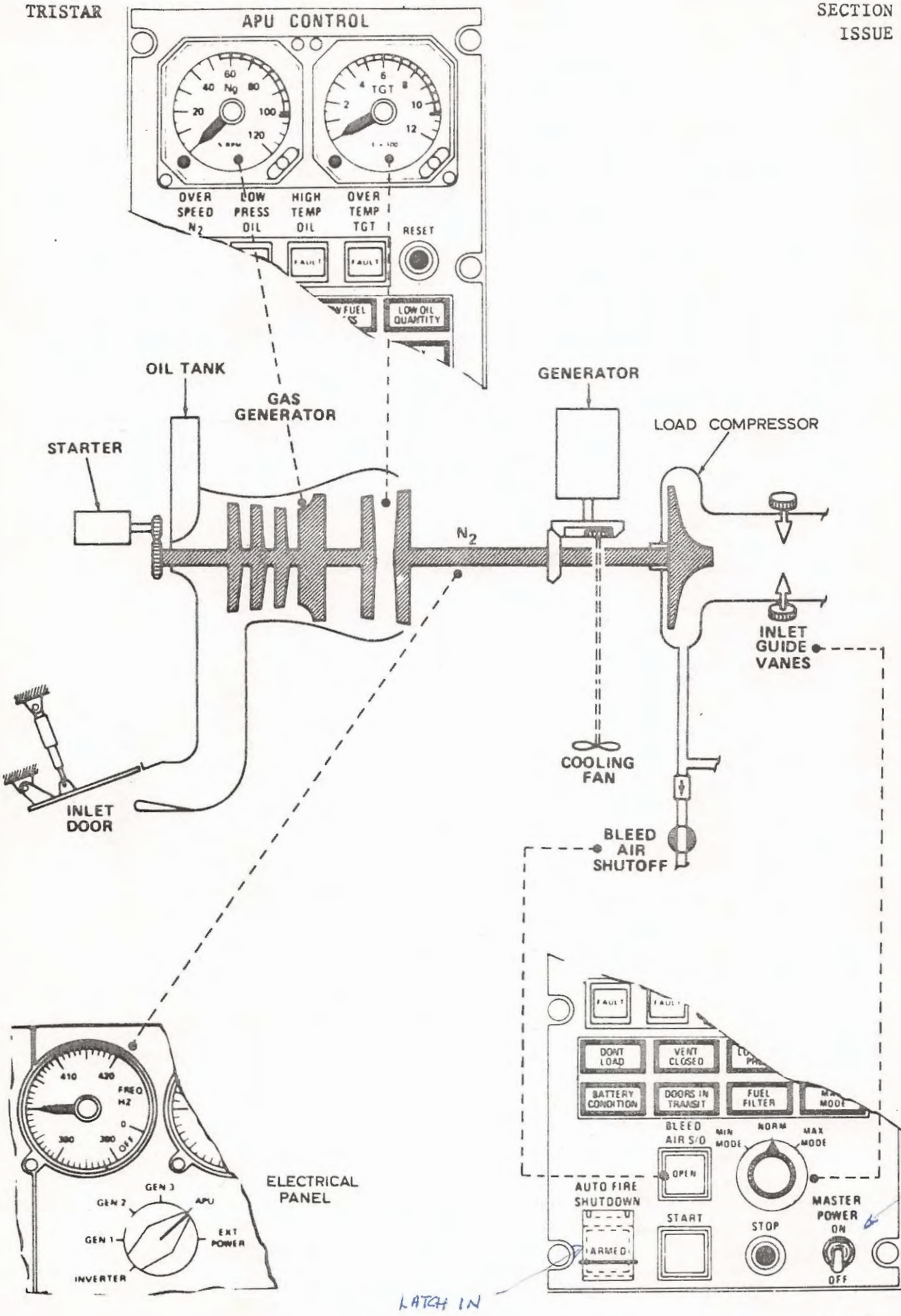
B - Inhibits cargo compartments A detectors.

SMOKE and DUCT lights will illuminate anytime their detectors operate, regardless of the position of the Detector Selector Rotary Switch.

TONE CUTOUT Switch

Cancels aural warning.

INTENTIONALLY BLANK


APU CONTROL
OVER SPEED N2
LOW PRESS OIL
HIGH TEMP OIL
OVER TEMP TGT
RESET
LOW OIL QUANTITY
OIL TANK
GAS GENERATOR
GENERATOR
STARTER
LOAD COMPRESSOR
N2
INLET GUIDE VANES
COOLING FAN
INLET DOOR
BLEED AIR SHUTOFF
ELECTRICAL PANEL
DONT LOAD
VENT CLOSED
BATTERY CONDITION
DOORS IN TRANSIT
FUEL FILTER
BLEED AIR S/O
OPEN
AUTO FIRE SHUTDOWN
ARMED
START
STOP
MASTER POWER ON
OFF
GEN 3
GEN 2
GEN 1
APU
EXT POWER
INVERTER
CONTROLS PRIMARY FUEL VALVE
LATCH IN BEFORE START.

AUXILIARY POWER UNIT

GENERAL

700-800 H.P.

The Pratt and Whitney ST6L A.P. can provide a source of pneumatic and electrical power both in flight and on the ground.

FUEL FROM NO 2 TANK.

The unit consists of a gas generator (Ng) and free turbine (N_2) the latter driving an air compressor and electrical generator.

Compressed air can be used for engine starting, air conditioning and through air turbine motors provide a source of hydraulic power.

The electrical generator can, on the ground, meet the total electrical power requirements likely to be demanded, or be parallel with the main engine driven generators (I.D.G.s)

Location of the unit is a fire proofed compartment in the bottom aft portion of the fuselage, forward of the No.2. engine and below the S duct.

Controls for starting, stopping and maintaining normal operation within safe limits are automatic. These controls ensure the correct sequencing of the start cycle, protect against overspeed, loss of oil pressure, high oil and gas temperatures.

Operation

Air is compressed through a four stage compressor. It then enters the combustion chamber where the fuel is added and the mixture ignited. Combustion gases flow to the first turbine stage which drives the compressor, residual gas being used to drive the free turbine (N_2) which is mechanically connected to the load compressor, generator and cooling fan. The cooling fan supplying air for the oil coolers, A.P.U. compartment and exhaust duct.

Automatic operation which includes maintaining the free turbine (N_2) at a constant speed is achieved by electronic control of the engine fuel system and load compressor.

Oil System

There are two self contained oil systems; one for the engine, the other for lubrication and cooling of the generator.

If the engine oil temperature is excessive or the pressure is low, the unit will automatically shut down. The shutdown will be accompanied with fault flags on the control panel and M.W.S. operation.

Excessive temperature or low oil pressure within the electrical generator oil system will result in indications on the electrical control panel and M.W.S. operation.

Fuel

Normally supplied from No.2. tank but other tanks can be utilised provided the appropriate selections are made with regards to pumps and crossfeed valves.

Load Compressor

The load compressor is a single stage centrifugal compressor which provides a source of compressed air. Variable inlet guide vanes control the amount of air going into the load compressor. The vanes can be positioned by the compressor mode selector switch.

The electrical generator takes priority over the load compressor e.g. if the demand for power from the free turbine (N_2) is in excess of the power available, the variable inlet guide vanes will move towards the closed position and therefore reduce compressor load. This will occur regardless of the mode of compressor operation.

Electrical Power

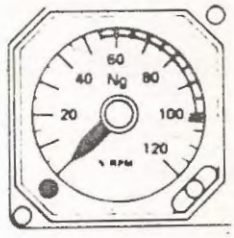
The aircraft battery supplies power for the electric starter and control circuitry. However if the D.C. GND SVCE BUS is powered the control circuitry will be transferred and powered from the GND SVCE BUS.

Inlet Door

This is a flush mounted door. It will open or close automatically during the start or stop cycles. If other than a normal shutdown occurs, the inlet door will remain open.

N_G TACHOMETER

The Ng (gas) RPM gauge indicator indicates the gas generator or Ng RPM. A green band extends from 55% to 105%, the 105% mark is accented by a red radial warning mark.

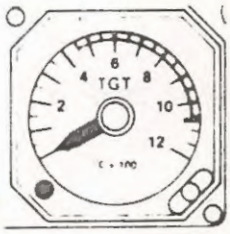


N_G TACHOMETER TEST BUTTON

Pressing the test switch causes the instrument to move to the 100% reading if the instrument is serviceable.

TURBINE GAS TEMPERATURE INDICATOR

Provides indication of engine operating temperature.



INST. INDICATES ONLY WHEN M.P.S. IS "ON"

TGT INDICATOR TEST BUTTON

Pressing the test switch causes the instrument to read approx. 1100°C providing the instrument is serviceable.

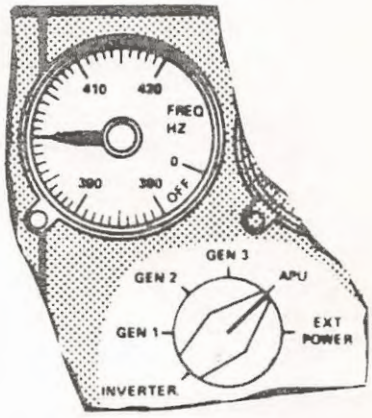
AC FREQUENCY METER

An indication of N2 is obtained by selecting APU on the AC frequency meter selector and monitoring APU generator frequency.

N2 95% = 380 Hz

N2 100% = 400 Hz

N2 105% = 420 Hz

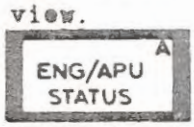


APU CONTROL PANEL

FAULT FLAGS

The following fault flags can appear on the APU panel indicating automatic APU shut down. In addition, operation of the LIGHTS TEST switchlight at the systems stations will result in all four flags coming into view.

MWS Caution



OVERSPEED N_2

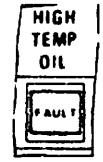
Indicates N_2 has exceeded 110%

LOW PRESS OIL

Indicates APU engine oil pressure less than minimum limit.

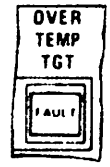
HIGH TEMP OIL

Indicates APU engine oil temperature exceeds maximum limit.



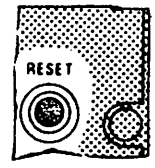
OVER TEMP TGT

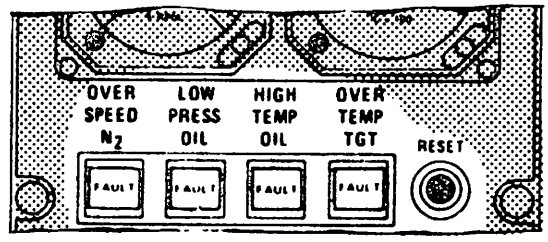
Indicates turbine gas temperature has exceeded the maximum limit of 1066°C during normal operation or 765°C during start.



FAULT FLAG RESET SWITCH

Switch permits resetting of the fault flags either after a shut down or LIGHTS test switch at the systems station has been activated. The master power switch must be on for the reset function.





APU CONTROL PANEL ADVISORY LIGHTS

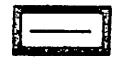
Certain conditions are displayed as advisory lights. Four can occur during normal operation the remainder indicating an abnormal condition.

DONT LOAD

The don't load light illuminates after the DOORS-IN-TRANSIT extinguishes and remains illuminated any time N_2 is not within the operating range, which is 95% to 105%. During shut down it will remain illuminated until the master power switch is turned off.

VENT CLOSED

Vent closed light indicates the APU compartment vent valve is not fully open. This condition occurs with an automatic or manual fire shut down. Normally open.



LOW OIL QUANTITY

The low oil quantity light illuminates when APU engine oil quantity below specific level and servicing is required (inhibited in flight).

BATTERY CONDITION

Battery condition light monitors the aircraft battery. If illuminated the battery is either overheated, or a cell shorted. It is located on the APU panel since the most critical battery load is the APU starting cycle.

DOORS IN TRANSIT

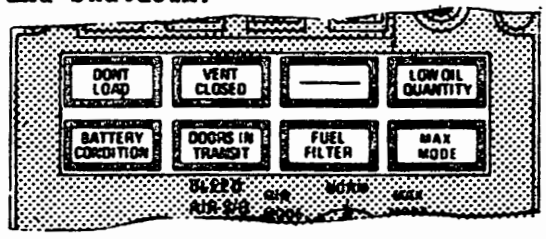
Door in transit light indicates inlet and ejector doors are not fully open or closed. Illuminated during start and shutdown cycles while doors are in motion. It takes approximately 10 seconds for doors to open or close.

FUEL FILTER

Fuel filter light indicates that the APU fuel filter has clogged or iced up.

MAX MODE

The max mode light illuminates as a reminder that the APU load compressor is operating at its maximum output. During engine starting using APU air the MAX MODE light illuminates regardless of the mode selector position. The light will remain illuminated until the engine start switch is unlatched. Sustained Max Mode operation could cause the APU gas generator (N_G) to overtemp and shutdown.

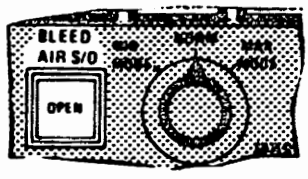


BLEED AIR SHUTOFF VALVE SWITCH

Permits opening and closing of bleed air shut off valve

IN indicates switch position. OPEN is illuminated and valve is open.

OUT OPEN is extinguished, valve is closed.



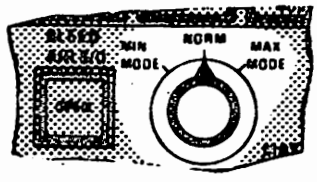
COMPRESSOR MODE SELECTOR

Selects APU compressor air flow output.

MIN Selects reduced flow of air

NORM Provides adequate air flow for air conditioning

MAX Large flow of air for rapid cabin environmental changes. (Compressor automatically operates in max mode when engine starting regardless of mode selector).



MASTER POWER SWITCH

ON connects A.P.U. to battery bus. Opens primary firewall shutoff valve and arms:-

(a) secondary firewall shutoff valve
(b) A.P.U. generator field and breaker open lights
(c) all A.P.U. indicators.

OFF disconnects the A.P.U. from battery bus and closes primary firewall shutoff valve.

START SWITCH

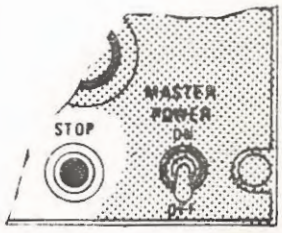
Momentary switch to initiate automatic start cycle.

STOP SWITCH

Pushbutton switch provides normal method of A.P.U. shutdown.

(1) GENS OFF IMMEDIATELY.
(2) 85 SECS TO SHUT DOWN CYCLE COMPLETION OF
(3) M.P.S OFF ON COMPLETION OF SHUT DOWN.

The switch injects a false overspeed signal into the shutdown circuit. This provides a check of overspeed protection on every shutdown. The N2 overspeed indicator is inhibited during normal shutdown.

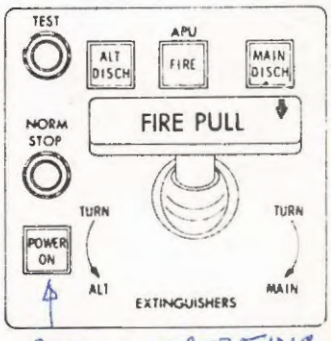


A.P.U. EXTERNAL CONTROL PANEL

The external A.P.U. panel is used for A.P.U. shutdown.

TEST SWITCH

Tests all lamps with the exception of power on switchlight.



NORM STOP SWITCH

A push button switch provides a means of stopping the A.P.U. at any time.

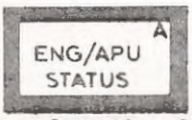
POWER ON SWITCH

Any time the Master Power Switch at the Systems Station is in the ON position, this light will be illuminated.

Momentarily pressing the switch results in the Master Power Switch reverting to the OFF position and the power on light extinguishing.

BEFORE OPERATING TO "OFF" AFTER "NORM STOP" WAIT FOR 85 SEC DELAY. (INLET DOOR SHUT).

MWS caution

The 

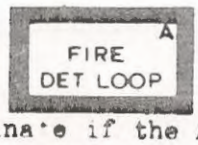
display will illuminate for the following faults:-

N_2 overspeed

Low oil pressure

High oil temperature

Over temp T.G.T.

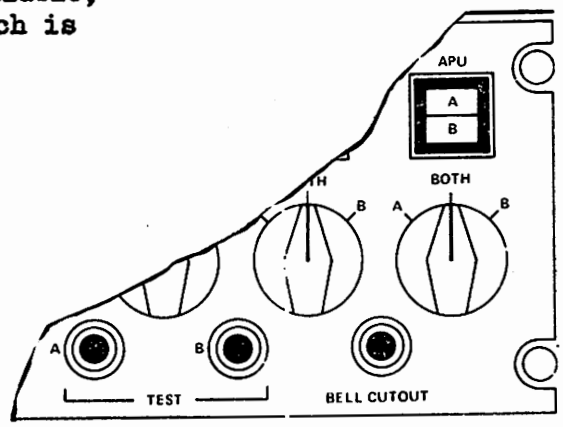
The 

display will illuminate if the A.P.U. fire detection system operates.

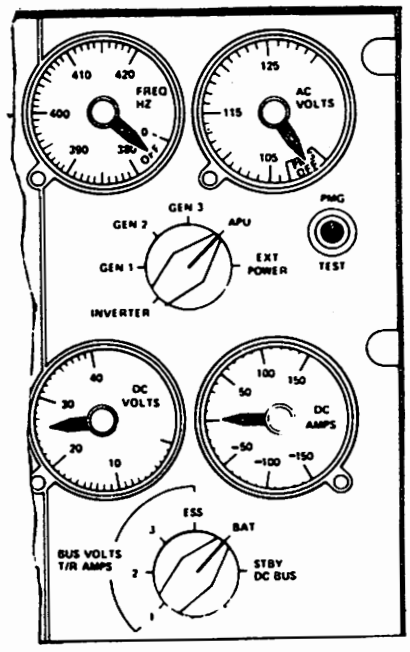
A.P.U. STARTING

The following procedure assumes that external power is available, that the battery switch is selected to the ON position and the initial Flight Deck checks have been completed.

A.P.U. Fire Detection Loop Test completed.

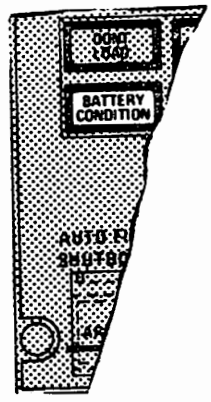


A.C. Meter Selector
A.P.U. Free turbine rotation can be confirmed by pressing the P.M.G. test switch and observing an increasing A.C. voltage indication.



D.C. Meters Selector. For the duration of starter motor operation the actual current being used is five times that indicated on the ammeter.

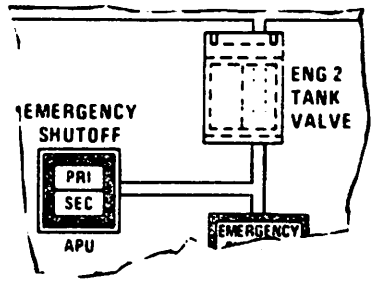
BATTERY CONDITION light extinguished.



A.P.U. STARTING (cont.)

A.P.U. MASTER POWER switch ON.

(Fuel System)

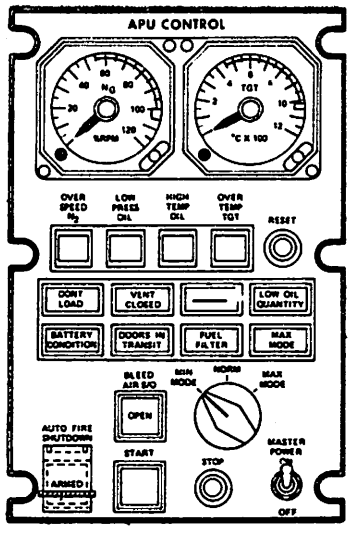


A.P.U. EMERGENCY SHUTOFF SEC light extinguished. (If illuminated light must extinguish when start button is pressed).

A.P.U. EMERGENCY SHUTOFF PRI light indicates during transit of valve.

ENG 2 TANK VALVE open (Normally left in open position).

AUTO FIRE SHUTDOWN switch in and ARMED illuminated.



BLEED AIR S/O switch out.

Compressor Mode Selector MIN MODE.

START switchlight Press. (approximately 2 seconds) CHECK.

LOW OIL QUANTITY extinguished.

DOORS IN TRANSIT light illuminates for approx. 11 seconds, followed by a sudden increase in the D.C. ammeter reading.

DON'T LOAD light illuminates.

(Electrical Panel)

GEN OIL PRESS illuminates then extinguishes with increasing Ng R.P.M. Battery Volts/amps will revert to normal indications on termination of starter and ignition sequence.

The start cycle will be automatically terminated and the A.P.U. shutdown if:-

(i) 55% Ng is not attained within 40 seconds of the DON'T LOAD light illuminating.

(ii) Slow acceleration of Ng

(iii) T.G.T. reaches 760°C before 55% Ng.

(iv) T.G.T. reaches 1010°C after 55% Ng. (OVER TEMP TGT flag).

A.P.U. STARTING (cont.)

An attempt to re-start may be made immediately if power is urgently required, but under normal conditions a 30 second delay would be preferred to allow the starter motor to cool. If after several attempts the engine fails to start, the STOP button must be pressed. This ensures the isolation of electrical power and the closing of inlet and ejector doors.

If, however, the R.P.M. fails to increase beyond 50% or T.G.T. does not further increase. Push the STOP button.

R.P.M. Stabilised.

DON'T LOAD light. Extinguished.

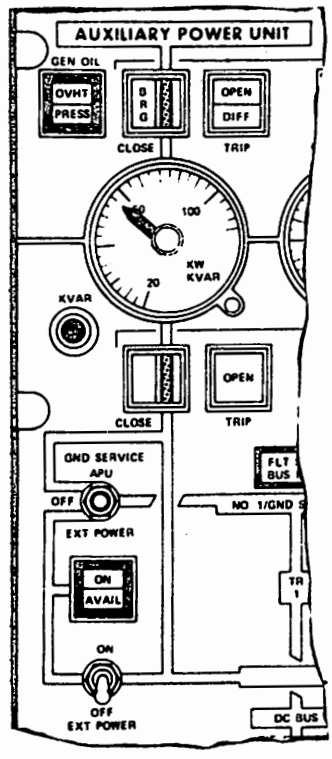
T.G.T. stabilised in green band.

(Electrical Panel)

A.P.U. Generator Field closed. (Flow bar illuminated).

A.P.U. Generator Breaker closed. If ground A.C. on line it will be necessary to place the EXT. POWER switch to the OFF position before A.P.U. Generator Breaker will energise.

DIFF light extinguished. Frequency and voltage normal.



Surging

Surging of the A.P.U. load compressor can occur due to transient mismatching of load and compressor output when the load is suddenly reduced.

Surging will not occur when the load requirement exceeds compressor output.

A.P.U. SHUTDOWN

Compressor Mode selector. MIN. MODE.

Reduce A.P.U. air load demands by turning off all E.C.S. packs, and A.T.M.s.

BLEED AIR S/O switchlight delatched. OPEN light extinguished.

A.P.U. SHUTDOWN (cont.)

The unloading of the compressor will be reflected by a decrease in T.G.T. indication.

If ground A.C. is available place EXT. POWER switch to the ON position.
A.P.U. Generator Breaker OPEN.
Load Meter will indicate zero and electrical system will transfer to external power.

STOP button Press.
CHECK.
A.P.U. Generator Field OPEN.

Reduction in Ng to 63% for 85 seconds. The idling of the A.P.U. at 63% Ng for 85 seconds before shutting down ensures adequate time for hot section cooling and temperature stabilization.
Pressing the START button any time before the idle period terminates will result in the A.P.U. accelerating back to normal operating speed.

Ng and T.G.T. readings decay.

DOORS IN TRANSIT illuminates for approx. 11 seconds.

DON'T LOAD light will illuminate approx. 40 seconds after STOP button is pressed.

MASTER POWER switch OFF.

(Electrical Panel)

GEN OIL PRESS & GENERATOR FIELD CLOSE Flowbar. Extinguish.

(Fuel Panel)

A.P.U. EMERGENCY SHUTOFF PRI intransit light indicates.

All lights on the A.P.U. Control panel extinguish.

WARNING

Shutting the A.P.U. down using the MASTER POWER switch will result in the air inlet door remaining open and likely damage to A.P.U. electrical circuits.

SAFETY EQUIPMENT AND PROCEDURES

CONTENTS

	Page No.
Aircraft emergency equipment chart	1
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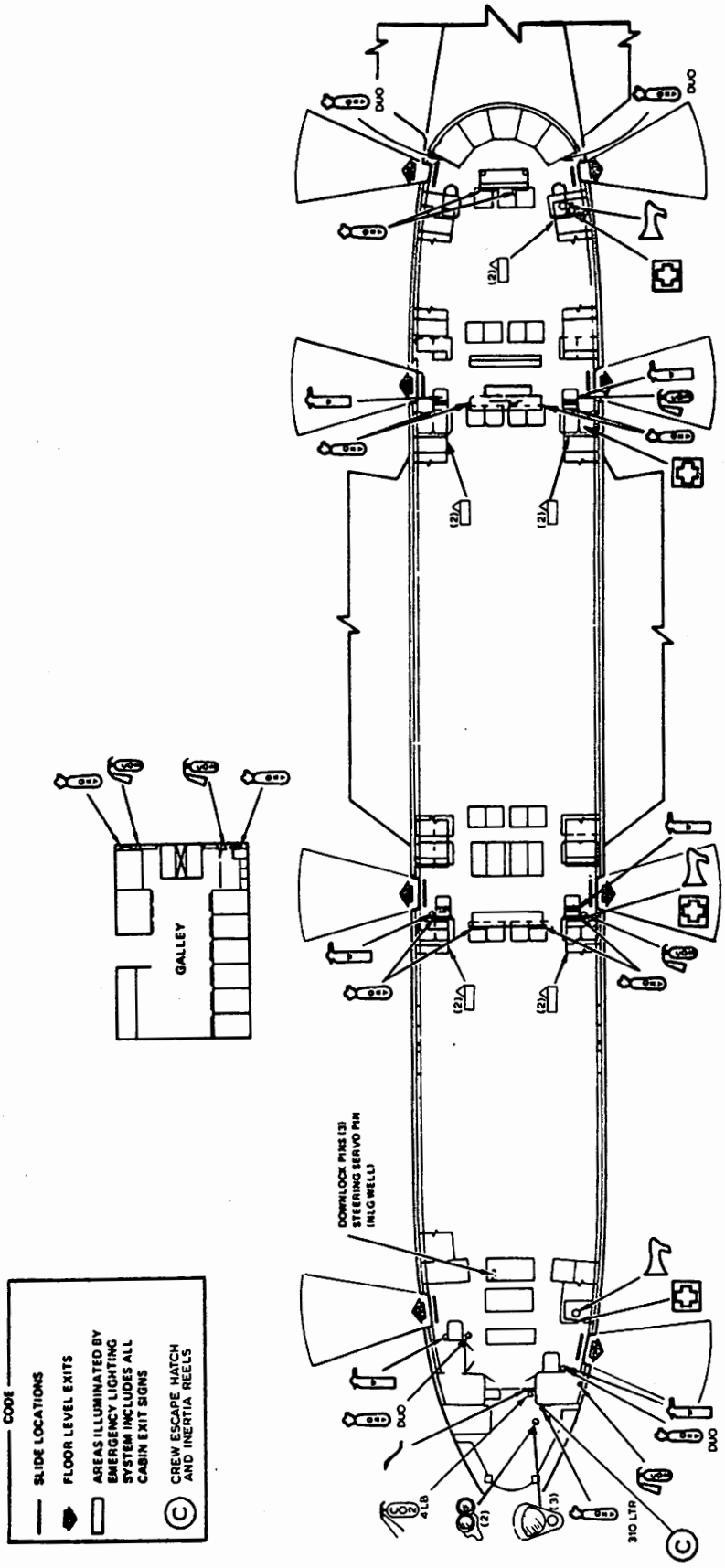
- Passenger	25
- Portable	26 - 27
Smoke protection	28

STANDARD EUROPEAN DIVISION EQUIPMENT

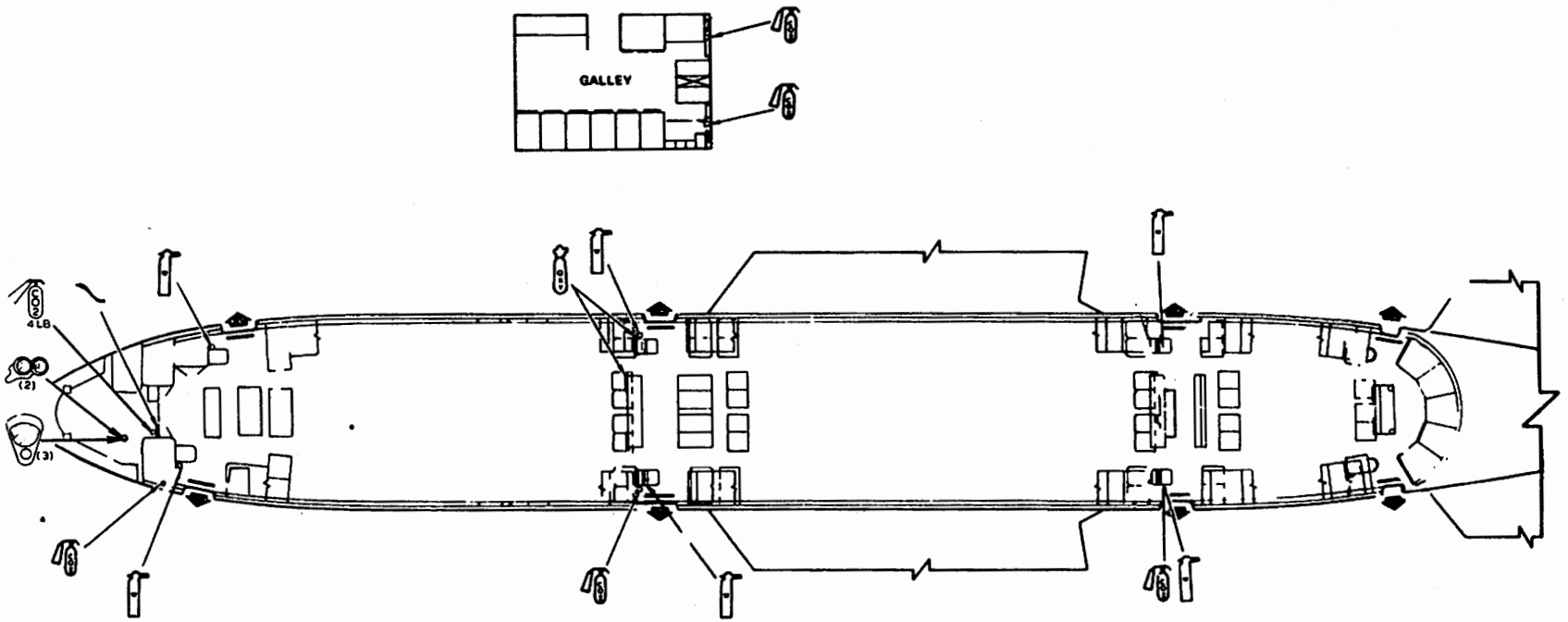
- First Aid kits
- Jemmy
- Life jackets
- Life cots
- Loud hailer
- Steriflex packs
- CO_2 Fire extinguishers
- Water glycol Extinguishers
- Smoke masks
- Smoke goggles
- Portable oxygen bottle for smoke mask

EMERGENCY EQUIPMENT LOCATION CHART



PILOT AND PASSENGER FIXED OXYGEN SYSTEMS - SEP 21 to 25

FIRE FIGHTING EQUIPMENT



CO_2 4LB FIRE EXTINGUISHER.....FLIGHT DECK - BEHIND P5 SEAT.

JEMMY.....FLIGHT DECK - BEHIND P5 SEAT.

CO_2 2½LB FIRE EXTINGUISHERS.....1 AT L1,L2 & L3 CABIN CREW STATIONS.
2 IN UNDERFLOOR GALLEY.

WATER GLYCOL FIRE EXTINGUISHERS.....1 AT EACH OF FORWARD 6 DOORS.

3 SMOKE MASKS
2 SMOKE GOGGLES).....STOWAGE BELOW P4 SEAT.

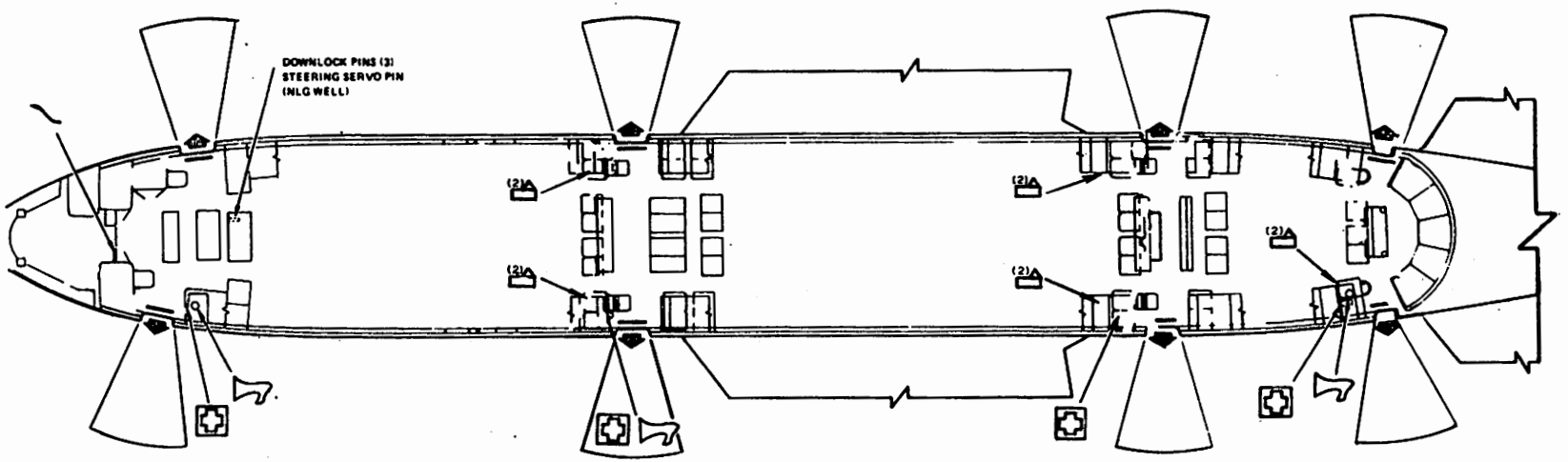
EMERGENCY EQUIPMENT LOCATION CHART

PORTABLE OXYGEN

DUO PAKS.....1 AT EACH FORWARD AND REAR CABIN CREW STATION.

SINGLE PAKS.....1 AT EACH OF THE OTHER CABIN CREW STATIONS.
2 IN UNDERFLOOR GALLEY.

310 LTR BOTTLE FOR SMOKE MASKS.....FLIGHT DECK STOWAGE TO LEFT OF P5.



DOOR CRANK.....FLIGHT DECK - REAR COAT CLOSET.

FIRST AID KITS & STERIFLEX PACKS)...SIDE WALL STOWAGES AT L1,L2 & L4 DOORS.

LOUD HAILERS.....SIDE WALL STOWAGES AT L1,L2, & L4 DOORS.

LIFE-JACKETS.....5 IN FLIGHT DECK.
1 AT EACH OF 14 CABIN CREW STATIONS.
1 UNDER EACH PASSENGER SEAT.

LIFE-SAVING COTS....2 UNDER FORWARD PASSENGER SEAT ROWS OF L2,R2,L3,R3 & L4 DOORS.

SAFETY EQUIPMENT AND PROCEDURE FORM

EQUIPMENT	QTY	CODE
CABIN ADDRESS	4	CA
EMERGENCY LIGHT SWITCHES	3	EL
EMERGENCY – DOOR CRANK	1	EC
EVACUATION SIGNAL PANELS	10	EV
FIRST AID KITS & STERIFLEX PACKS	4	FA
JEMMY	1	JY
LIFE JACKETS	19+	LJ
LIFE COTS	10	LC
LOUD HAILER	3	LH

EMERGENCY EXITS

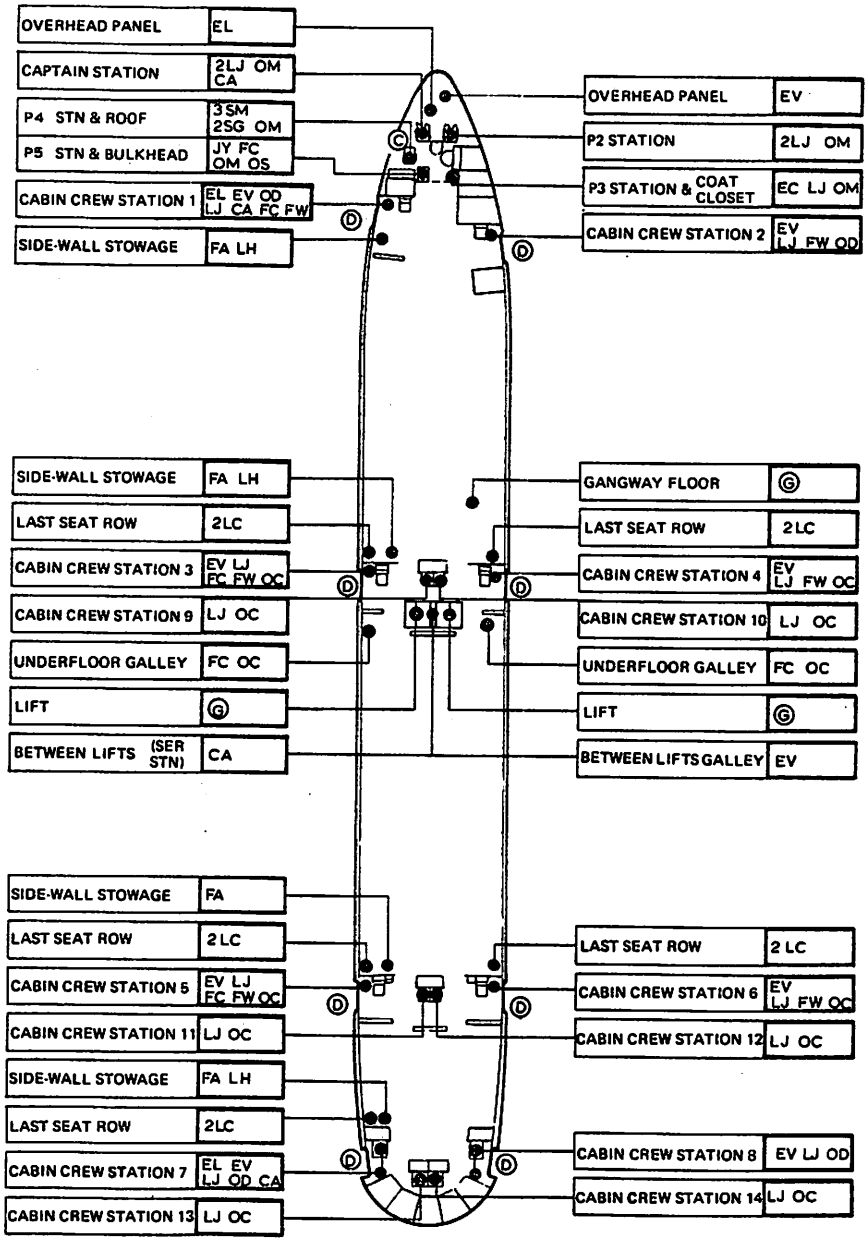
DOORS & ESCAPE SLIDES	8	(D)
CREW HATCH & INERTIA REELS	1	(C)
GALLEY ESCAPE HATCHES	3	(G)

FIRE PROTECTION

CO2 EXTINGUISHERS	6	FC
WATER EXTINGUISHERS	6	FW
SMOKE MASKS	3	SM
SMOKE GOGGLES	2	SG
ASBESTOS GLOVES		AG

OXYGEN

PILOT MASKS	5	OM
PORTABLE CREW SETS – SINGLE	12	OC
PORTABLE CREW SETS – DUAL	4	OD
PORTABLE FOR SMOKE MASK	1	OS



CABIN CREW FLIGHT SAFETY RESPONSIBILITIES

CABIN CREW No.1

TAKE-OFF/LANDING	L1 door
EVACUATION	L1 door and escape slide
AREA OF RESPONSIBILITY	Forward cabin
ALERT POSITION	L1 I/C station
BRIEFING AREA	Left forward cabin - Rows 6 to 14
PASSENGER FLOW	Forward to L1 door
ALTERNATIVE EXIT	R1 door and escape slide
RECEIVE REPORT FROM	Cabin crew No.2
FINAL REPORT TO	Purser

CABIN CREW No.3

TAKE-OFF/LANDING	L2 door
EVACUATION	L2 door and escape slide
AREA OF RESPONSIBILITY	Forward centre cabin
ALERT POSITION	L2 I/C station
BRIEFING AREA	Left forward centre cabin
PASSENGER FLOW	Forward to L2 door
ALTERNATIVE EXITS	R2 door or forward to L1 door
IF NO CABIN CREW No.10	Check galley clear and lifts DOWN
RECEIVE REPORTS FROM	Cabin crew No.s 4,10,11
FINAL REPORT TO	Purser

CABIN CREW No.9 - PURSER

TAKE-OFF/LANDING	L2 centre
EVACUATION	Control with loud hailer
AREA OF RESPOSIBILITY	All passenger cabins
ALERT POSITION	Flight Deck
CABIN CREW BRIEFING	L1 or main service I/C
EMERGENCY ANNOUNCEMENT	L1 or main service C/A
BRIEFING AREA	First Class cabin - Rows 1 to 4
RECEIVE REPORTS FROM	Cabin Crew No.s 1,3,5,7
FINAL REPORT TO	Flight Deck

CABIN CREW No.5

TAKE-OFF/LANDING	L3 door
EVACUATION	L3 door and escape slide
AREA OF RESPONSIBILITY	Rear centre cabin
ALERT POSITION	L3 I/C station
BRIEFING AREA	Left rear centre cabin
PASSENGER FLOW	Rearward to L3 door
ALTERNATIVE EXITS	R3 or L4 door
RECEIVE REPORTS FROM	Cabin crew No.s 6,12
FINAL REPORT TO	Purser

CABIN CREW No. 11

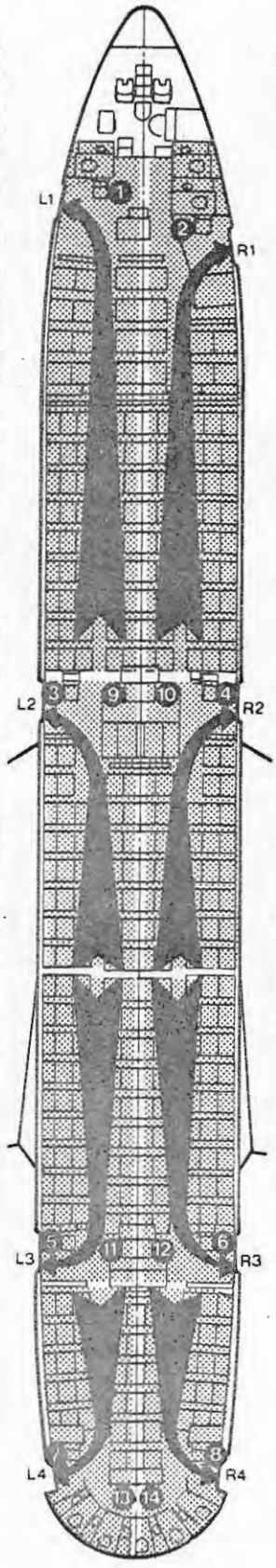
TAKE-OFF/LANDING	L3 centre
EVACUATION	Regulate passenger flow to L3 L4 doors
ALERT POSITION	L3 I/C station
RESPONSIBILITIES	Assist stowage of trolleys
FINAL REPORT TO	Cabin crew No. 3

CABIN CREW No.7

TAKE-OFF/LANDING	L4 door
EVACUATION	L4 door and escape slide
AREA OF RESPONSIBILITY	Rear cabin
ALERT POSITION	L4 I/C station
BRIEFING AREA	Left rear cabin
PASSENGER FLOW	Rearward to L4 door
ALTERNATIVE EXIT	R4 or L3 door
RECEIVE REPORT FROM	Cabin crew No.8
FINAL REPORT TO	Purser

CABIN CREW No.13

TAKE-OFF/LANDING	L4 centre
EVACUATION	1. Leave aircraft 2. Check L3 slide in position 3. Marshall passengers on port side
ALERT POSITION	L4 I/C station
RESPONSIBILITY	Assist stowage of trolleys



CABIN CREW No.2

TAKE-OFF/LANDING	R1 door
EVACUATION	R1 door and escape slide
AREA OF RESPONSIBILITY	Right forward cabin
ALERT POSITION	R1 I/C station
BRIEFING AREA	Right forward cabin - Rows 6 to 14
PASSENGER FLOW	Forward to R1 door
ALTERNATIVE EXIT	L1 door
FINAL REPORT TO	Cabin crew No.1

CABIN CREW No.4

TAKE-OFF/LANDING	R2 door
EVACUATION	R2 door and escape slide
AREA OF RESPONSIBILITY	Right forward centre cabin
ALERT POSITION	R2 I/C station
BRIEFING AREA	Right forward centre cabin
PASSENGER FLOW	Forward to R2 door
ALTERNATIVE EXIT	L2 or R1 door
FINAL REPORT TO	Cabin crew No.3

CABIN CREW No.10

TAKE-OFF/LANDING	R2 centre
EVACUATION	Regulate passenger flow to L2 R2 doors
AREA OF RESPONSIBILITY	Galley and lifts
RESPONSIBILITIES	1. Secure galley & check clear 2. Return lifts to DOWN
FINAL REPORT TO	Cabin crew No.3

CABIN CREW No.6

TAKE-OFF/LANDING	R3 door
EVACUATION	R3 door and escape slide
AREA OF RESPONSIBILITY	Right rear centre cabin
ALERT POSITION	R3 I/C station
BRIEFING AREA	Right rear centre cabin
PASSENGER FLOW	Rearward to R3 door
ALTERNATIVE EXIT	L3 or R4 door
FINAL REPORT TO	Cabin crew No.5

CABIN CREW No.12

TAKE-OFF/LANDING	R3 centre
EVACUATION	Regulate passenger flow to R3 R4 doors
ALERT POSITION	R3 I/C station
RESPONSIBILITY	Assist stowage of trolleys
FINAL REPORT TO	Cabin crew No.5

CABIN CREW No.8

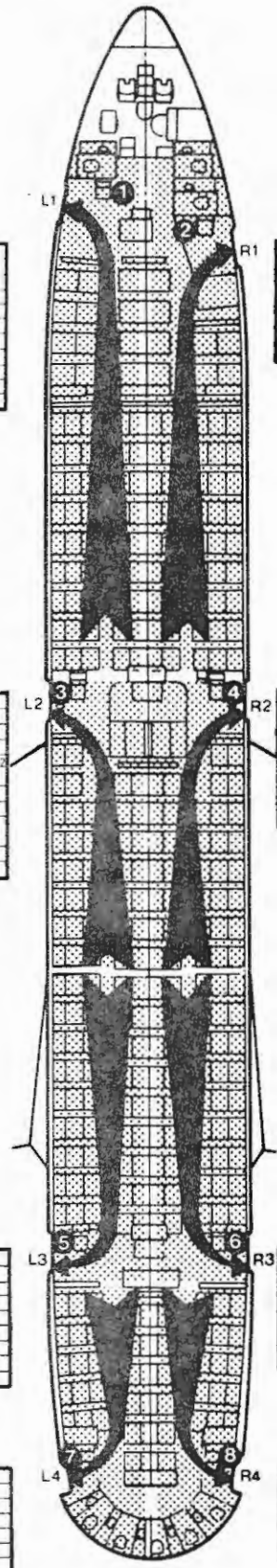
TAKE-OFF/LANDING	R4 door
EVACUATION	R4 door and escape slide
AREA OF RESPONSIBILITY	Right rear cabin
ALERT POSITION	R4 I/C station
BRIEFING AREA	Right rear cabin
PASSENGER FLOW	Rearward to R4 door
ALTERNATIVE EXIT	L4 or R3 door
FINAL REPORT TO	Cabin crew No. 7

CABIN CREW No.14

TAKE-OFF/LANDING	R4 centre
EVACUATION	1. Leave aircraft 2. Check R3 slide in position 3. Marshall passengers on stbd side
ALERT POSITION	R4 I/C station
RESPONSIBILITY	Assist stowage of trolleys

CABIN CREW FLIGHT SAFETY RESPONSIBILITIES

FLIGHT PURSER AND 7 CABIN CREW



CABIN CREW No.1- FLIGHT PURSER

TAKE-OFF/LANDING	L1 door
EVACUATION	L1 door and escape slide
AREA OF RESPONSIBILITY	All passenger cabins
ALERT POSITION	Flight Deck
CABIN CREW BRIEFING	L1 I/C
EMERGENCY ANNOUNCEMENT	L1 C/A
BRIEFING AREA	Left forward cabin - Rows 1 to 14
PASSENGER FLOW	Forward to L1 door
ALTERNATIVE EXIT	R1 door and escape slide
RECEIVE REPORTS FROM	Cabin Crew No.s 2,3,5,7
FINAL REPORT TO	Flight Deck

CABIN CREW No.2

TAKE-OFF/LANDING	R1 door
EVACUATION	R1 door and escape slide
AREA OF RESPONSIBILITY	Right forward cabin
ALERT POSITION	R1 I/C station
BRIEFING AREA	Right forward cabin - Rows 2 to 14
PASSENGER FLOW	Forward to R1 door
ALTERNATIVE EXIT	L1 door
FINAL REPORT TO	Flight Purser

CABIN CREW No.3

TAKE-OFF/LANDING	L2 door
EVACUATION	L2 door and escape slide
AREA OF RESPOSIBILITY	Forward centre cabin
ALERT POSITION	L2 I/C station
BRIEFING AREA	Left forward centre cabin -Rows 15 to 22 and assist Flight Purser
PASSENGER FLOW	Forward to L2 door
ALTERNATIVE EXITS	R2 door or forward to L1 door
RESPONSIBILITIES	1. Secure galley & check clear 2. Return lifts to DOWN
RECEIVE REPORTS FROM	Cabin Crew No.4
FINAL REPORT TO	Flight Purser

CABIN CREW No.4

TAKE-OFF/LANDING	R2 door
EVACUATION	R2 door and escape slide
AREA OF RESPONSIBILITY	Right forward centre cabin
ALERT POSITION	R2 I/C station
BRIEFING AREA	Right forward centre cabin Rows 15 to 22 and assist Cabin Crew No.2
PASSENGER FLOW	Forward to R2 door
ALTERNATIVE EXITS	L2 or R1 door
FINAL REPORT TO	Cabin Crew No.3

CABIN CREW No.5

TAKE-OFF/LANDING	L3 door
EVACUATION	L3 door and escape slide
AREA OF RESPONSIBILITY	Rear centre cabin
ALERT POSITION	L3 I/C station
BRIEFING AREA	Left rear centre cabin -Rows 23 to 31
PASSENGER FLOW	Rearward to L3 door
ALTERNATIVE EXITS	R3 or L4 door
RECEIVE REPORTS FROM	Cabin crew No. 6
FINAL REPORT TO	Flight Purser

CABIN CREW No.6

TAKE-OFF/LANDING	R3 door
EVACUATION	R3 door and escape slide
AREA OF RESPONSIBILITY	Right rear centre cabin
ALERT POSITION	R3 I/C station
BRIEFING AREA	Right rear centre cabin -Rows 23 to 31
PASSENGER FLOW	Rearward to R3 door
ALTERNATIVE EXIT	L3 or R4 door
FINAL REPORT TO	Cabin crew No.5

CABIN CREW No.7

TAKE-OFF/LANDING	L4 door
EVACUATION	L4 door and escape slide
AREA OF RESPONSIBILITY	Rear cabin
ALERT POSITION	L4 I/C station
BRIEFING AREA	Left rear cabin
PASSENGER FLOW	Rearward to L4 door
ALTERNATIVE EXIT	R4 or L3 door
RECEIVE REPORT FROM	Cabin crew No.8
FINAL REPORT TO	Flight Purser

CABIN CREW No.8

TAKE-OFF/LANDING	R4 door
EVACUATION	R4 door and escape slide
AREA OF RESPONSIBILITY	Right rear cabin
ALERT POSITION	R4 I/C station
BRIEFING AREA	Right rear cabin
PASSENGER FLOW	Rearward to R4 door
ALTERNATIVE EXIT	L4 or R3 door
FINAL REPORT TO	Cabin crew No. 7

EVACUATION

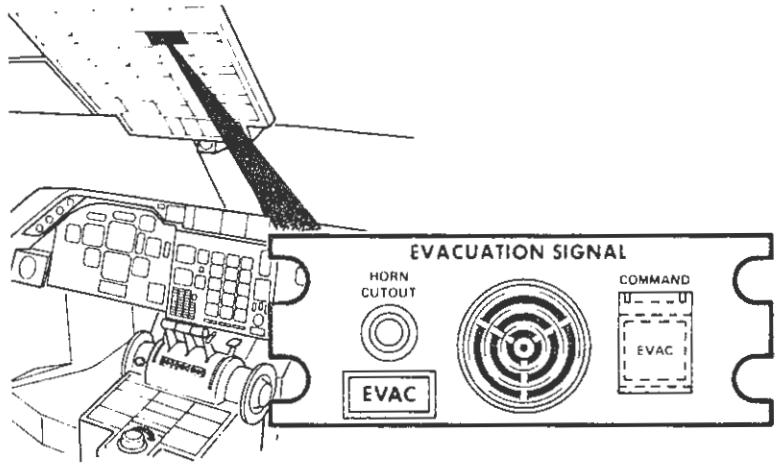
EVACUATION ALARM SYSTEM

The system provides visual and aural command signals to evacuate the aircraft.

The EVACUATION SIGNAL panels are located :-

Flight deck roof panel (1)
Aft side of each cabin door (8)
Galley (1)

FLIGHT DECK PANEL



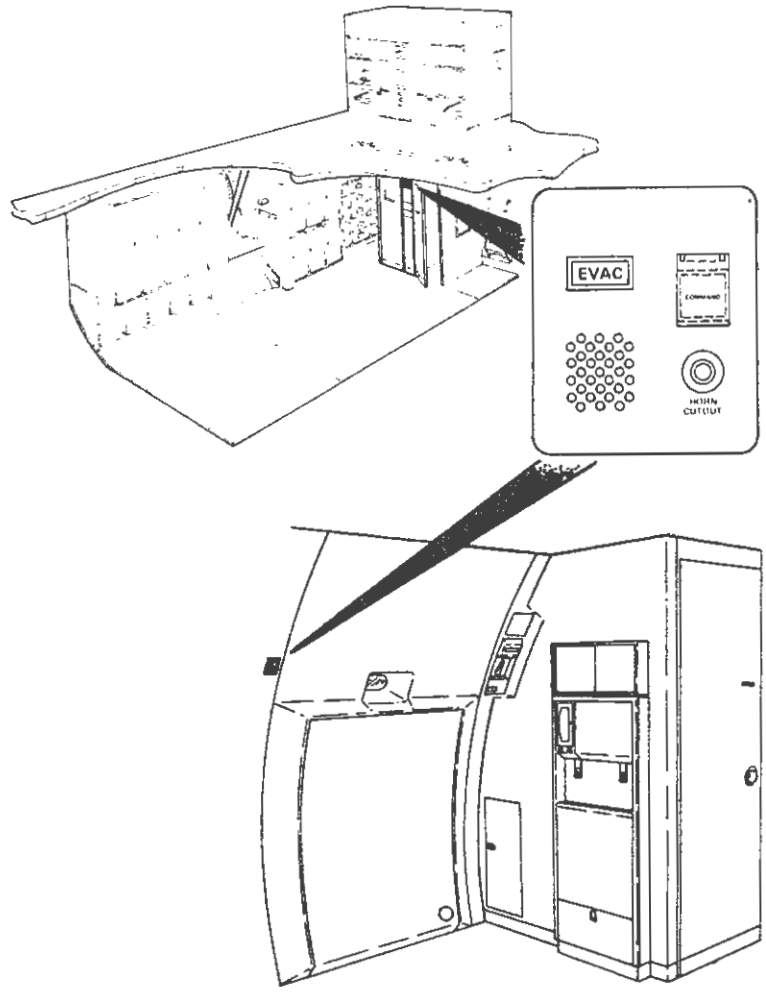
COMMAND switch

A guarded switch which when energised sounds a horn intermittently on all panels in the aircraft and causes the red EVAC light on all panels to flash

HORN CUTOUT switch

When pressed, silences the horn in the flight deck only.

CABIN AND GALLEY PANELS



Controls — Each of the cabin and galley panels has similar controls to the flight deck panel but the COMMAND switch on each is wired to the OFF position.

HORN CUTOUT switch — When pressed, silences the horn at that position only.

Cancellation of EVAC command — The red flashing EVAC lights can only be extinguished by releasing the COMMAND switch on the panel that initiated the alarm.

EMERGENCY EXITS

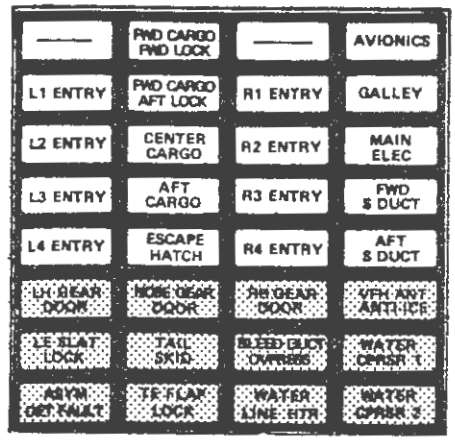
DOOR WARNING

P3 Annunciator Panel

Normal Indication — Extinguished

Lamp ON — This indicates that the door or hatch is not correctly locked shut.

Note that for the forward cargo door and the No.2 engine S duct panel, lamps are provided for the forward and rear locking mechanisms.



DOORS

Introduction

The cabin is fitted with 8 Class A doors, four each side, opening in, up and over. The size of the doors and the operation is identical.

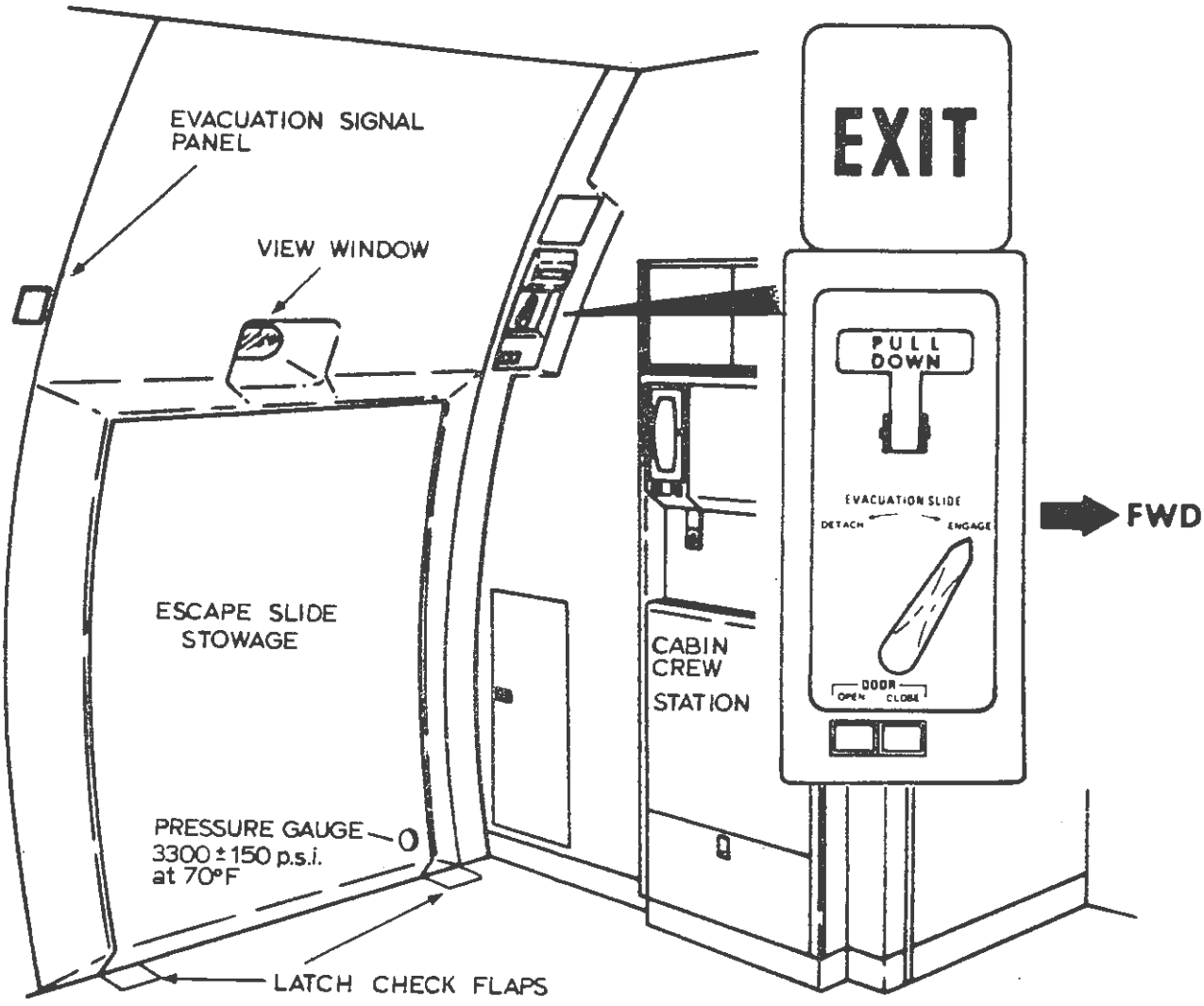
All doors are normally operated electrically. In an emergency they can be opened mechanically (providing the cabin is depressurised).

Provision is also made to wind the doors closed using a handbrace.

Evacuation slides are fitted to each door. Deployment of the slides is dependent upon the position of latches in the door entrance.

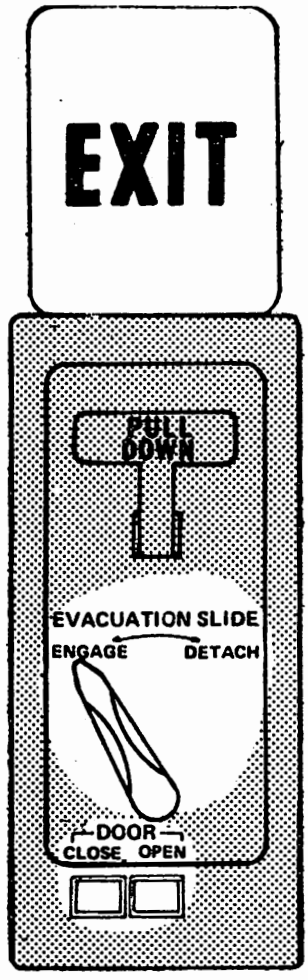
The position of the latches is controlled by a lever on the door control panel.

TYPICAL 'L' DOOR



Door Control Panel

All of the door control panels are located on the forward side of the door frame.



EXIT lamp

This sign is controlled by the emergency lighting system.

EVACUATION SLIDE

Selector Lever

This controls the position of the slide deployment latches.

ENGAGE

The latches are engaged on the slide bar and as the door is opened the slide is deployed and inflated.

This is the NORMAL position of the lever at all times that the door is closed.

DETACH

The latches are released from the slide bar and as the door opens the slide remains attached to the door.

Door Control Switches

These switches control door operation.

OPEN

This switch is armed only when the evacuation slide lever is selected to DETACH.

Pressing the switch electrically unlocks, and raises the door.

CLOSE

This switch is armed only when the evacuation slide lever is selected to ENGAGE.

When pressed, the door electrically closes and locks.

As the door closes, the evacuation slide latches are engaged on the slide bar.

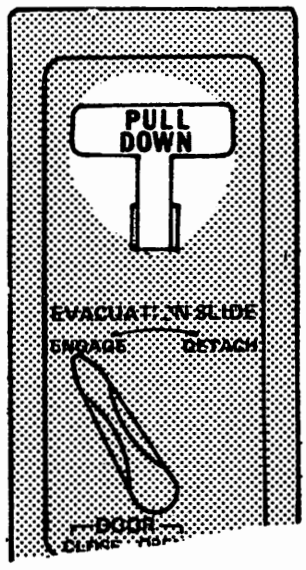
Door Emergency Handle

This handle is normally protected by a transparent plastic cover.

When initally pulled the door is mechanically unlocked.

Further pulling of the handle allows a spring mechanism to fully open the door.

If the emergency handle is pulled with the slide lever selected to ENGAGE (the normal position) the slide will deploy and inflate.



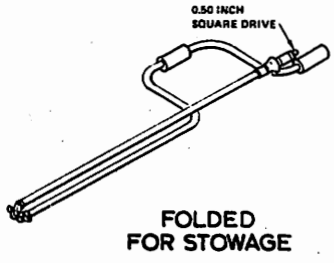
Warning

When opening a door by the above methods it is imperative to stand well clear of the door.

Door Closing Handbrace

The doors can be manually closed by inserting a handbrace in socket which is beneath the door control panel.

The handle is normally stowed in the flight deck stbd. aft closet.



FOLDED
FOR STOWAGE

External Door Operation

The doors can be opened and shut electrically and opened mechanically. The forward left-hand door can also be wound shut from the outside.

Interlocks ensure that the evacuation slide is detached whenever the door is operated externally.

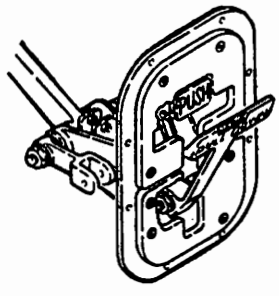
The control panel consists of an operating handle and toggle switch.

External Handle

The handle has 3 detents.

1st Detent

Detaches the evacuation slide and arms the toggle switch for electric door operation.



2nd Detent

Mechanically unlocks the door.

3rd Detent

Spring mechanism opens the door.

External Switch

The switch is spring centre off and is only armed when the external handle is pulled to the first detent.

UP to OPEN - The door is electrically unlocked and opened.

DOWN to CLOSE - The door is electrically closed and locked.

ESCAPE SLIDES

DATA

Double channelled.

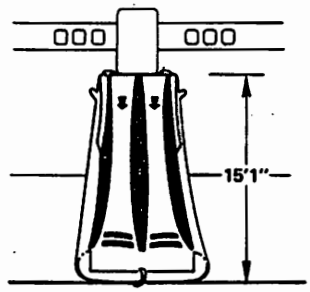
Evacuation rate :- 84 passengers per minute approximately.

Automatic inflation.

Secondary manual inflation.

Slide can be hand held in the event of a puncture.

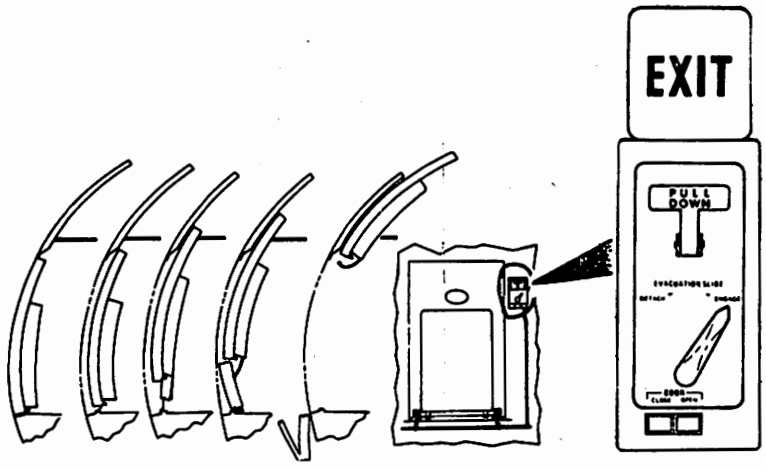
L3 and R3 slides fitted with a fence to prevent use of forward channel if slide fouls wing.



PASS. DOOR SLIDE (TYPE A)
TYPICAL LEFT & RIGHT

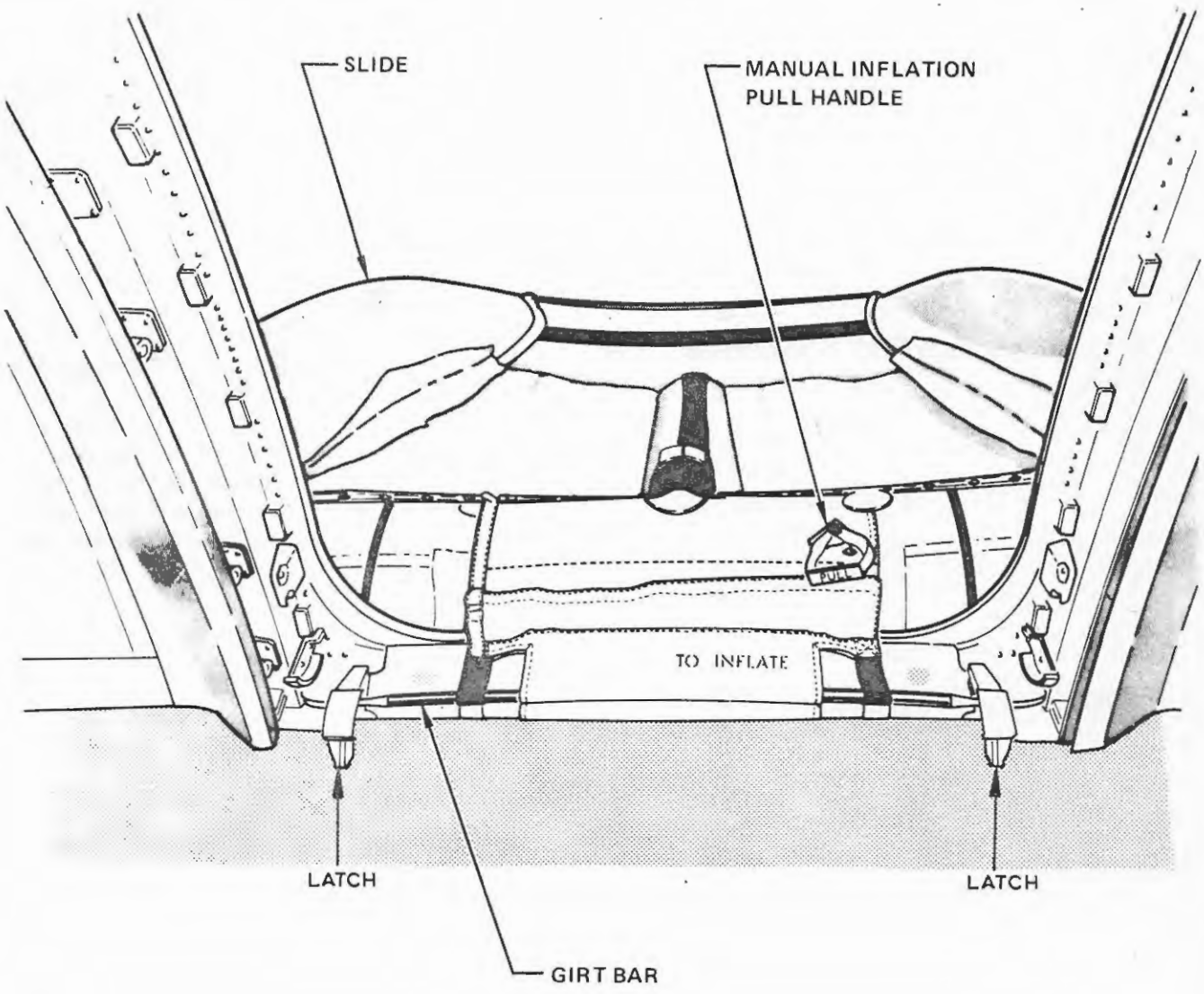
SLIDE DEPLOYMENT

1. Door lever in ENGAGE position.
2. Remove plastic cover.
3. Pull red handle.
4. Door lock releases and door comes in.
5. Door moves upward with girt bar latched.
6. Slide is extracted and ejected out of door automatically.
7. Slide is then automatically inflated.
8. If slide does not inflate - Pull manual handle on slide.



1sec. 2sec. 3sec. 4sec. 6sec.

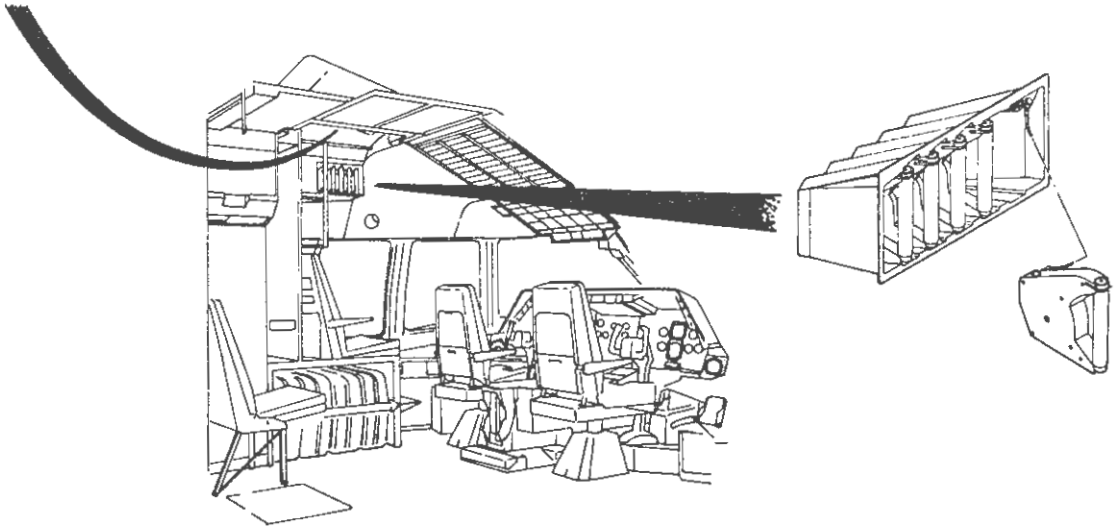
ESCAPE SLIDE - DEPLOYED AND INFLATED
(View looking outboard)



EMERGENCY EXITS

FLIGHT DECK ESCAPE HATCH

A roof hatch is located above the P4 seat. To open it the 'T' handle is pulled down.



Inertia reel escape system

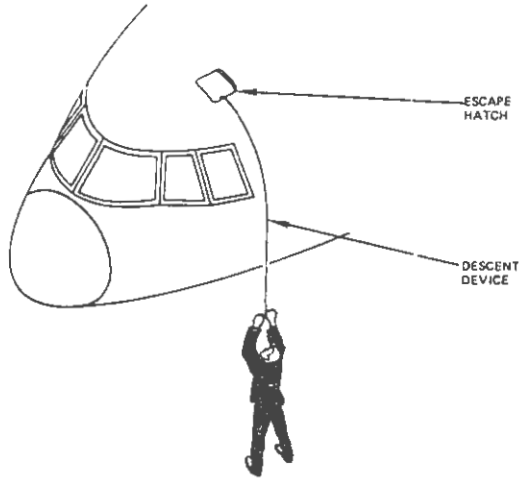
Five inertia reel devices for the occupants of the flight deck are stowed adjacent to the escape hatch.

Each device consists of a steel tape coiled around an inertia type reel in the handle. The inertia reel will automatically adjust to uncoil at a rate determined by the user's weight to give a landing speed equivalent to a 3 ft. drop.

Emergency descent

i. Open hatch.
ii. Grasp inertia reel handle firmly.
iii. Climb through hatch.
iv. Allow body to slip off lip of hatch opening.

Face fuselage during descent, maintaining a firm grip on the inertia reel handle.



GALLEY EMERGENCY EXITS

There are two methods of evacuation from the galley into the cabin.

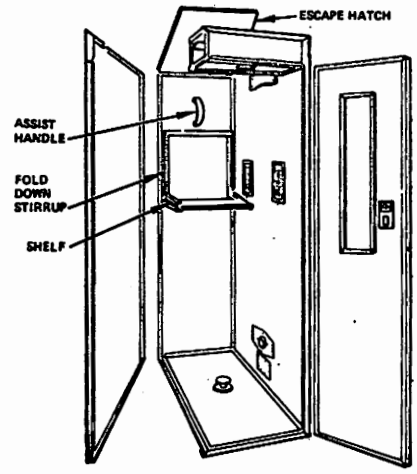
i. Through the lift escape hatches.
ii. Through the galley escape hatch.

Lift Escape hatches

A hatch in the ceiling of each lift allows an exit into the cabin in an emergency when electrical power is not available, providing the lift is at :-

galley level
or
at least three fourths of the way to galley level.

(If a lift is at cabin level when electrical power is lost it cannot be used as an emergency exit unless hand cranked to galley level)



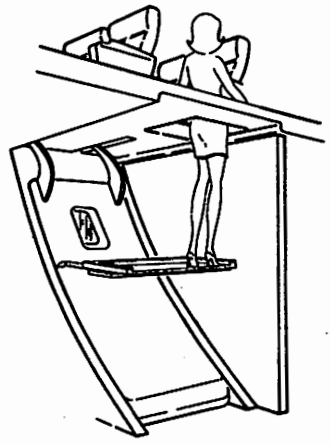
Evacuation via lift hatches

i. Open lift door with emergency latch.
ii. Enter lift and pull down stirrup.
iii. Using stirrup and assist handle, climb up on to shelf.
iv. Reach to the roof and push up on hatch. The hatch will latch in the open position.
v. Climb on top of the lift.
vi. Open door into cabin by turning 'T' handle.

Evacuation via Galley hatch

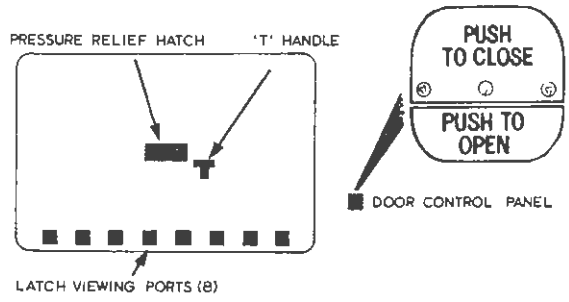
i. Climb up onto galley work shelf which is mounted on the inside of the service door.

ii Unlock and push open the hatch in the cabin floor above head.



CARGO DOORS

C1A - FORWARD CARGO DOOR



To open door

i. Push in base of 'T' handle, then pull top of 'T' down and hold for 6 secs. - Door opens approximately 3 inches.

ii. Push in PUSH TO OPEN switch on door control panel.
Note:- Stand clear of door which, being hinged at the top, will swing out and up.

iii. Hold PUSH TO OPEN switch in until door is fully open.

To close door

i. Push in PUSH TO CLOSE switch on door control panel.
Note:- Stand clear of downward swinging door.

ii. Hold PUSH TO CLOSE switch in until door stops approximately 3 inches clear of fuselage, and hold for further 6 secs.

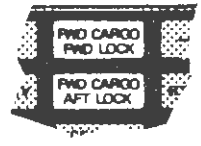
iii. Push top of 'T' handle flush with fuselage. - Door closes fully.

NOTE: If 'T' handle does not recess fully and remain in, the door has not closed and locked.

Door warnings

Flight Deck:-

FWD CARGO FWD LOCK and FWD CARGO AFT LOCK lights on the P3 annunciator panel are extinguished when the door is locked.

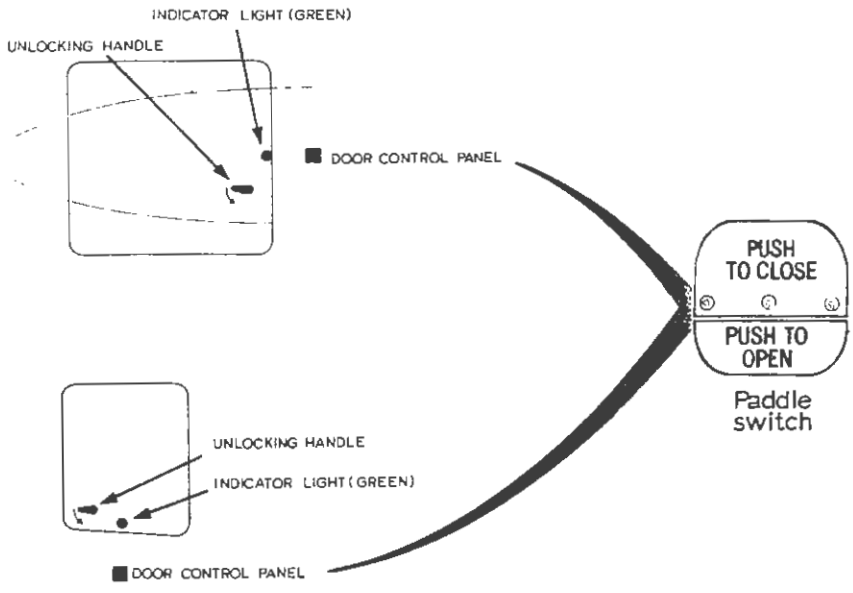


External:-

'T' handle fully recessed.
All 8 latches show green when seen through the viewing ports when they are correctly positioned in the locked position.
Should any latch not show green - it is not fully locked.

C2 - CENTRE CARGO DOOR

C3 - AFT CARGO DOOR



Centre and aft cargo doors are plug type which move upwards off pressure stops and outwards to open.

To open doors

i. Turn unlocking handle to UNLOCK and hold for 15 secs.

ii. Hold PUSH TO OPEN switch in until door is fully open.
- Stand clear of opening door.

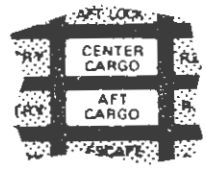
To close doors

i. Hold PUSH TO CLOSE switch in until green indicator light illuminates.
- Stand clear of closing door.

Door warnings

Flight deck :-

CENTER CARGO / AFT CARGO lights on the P3 annunciator panel are extinguished when the doors are locked.



External :-

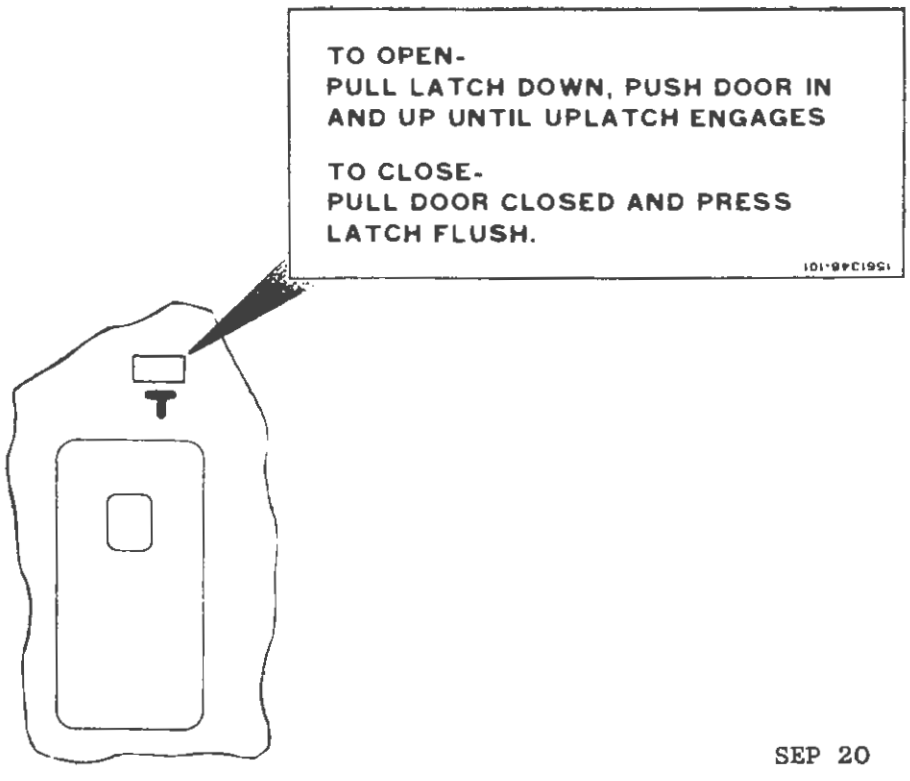
The green indicator lights on the doors are illuminated when the doors are locked.

CARGO DOOR WARNING TEST

Conditions	Door warning lights on P3 annunciator panel - OUT. Aural test warning switch to configuration.
Test	Press aural warning test button.
Indication	Normal test configuration warning - Red warning light and hooter. All 4 cargo door warning lights on annunciation panel illuminated. Failure of a door warning light to illuminate indicates a proximity switch has failed to sense a locked condition.

GALLEY SERVICE DOOR

An inward opening hinged door with pressure stops, opened and closed from inside and outside by a latch handle.



DRAFT FLYING STAFF INSTRUCTION

OXYGEN

LOCKHEED L.1011

CREW OXYGEN MASKS

Action

In the event of cabin pressure failure -

1. Crew oxygen masks ... ... Don
2. Safety straps ... ... Tighten

Captain absent from flight deck above 35,000' -

1. Captain's mask ... ... Select safety pressure OFF
2. Co-pilot's " ... ... " " " ON

Before carrying out in situ check -

Captain's oxygen mask ... ... Select safety pressure OFF

Following in situ check -

Captain's oxygen mask ... ... Select safety pressure ON

Explanation

Tests have shown that the efficiency of the existing crew oxygen mask falls off at altitudes in excess of 35,000' unless safety pressure is selected ON or the safety straps are tightened after donning.

For technical reasons it is only feasible to pre-select safety pressure on one mask, therefore pending availability of improved masks, C.A.A. dispensation has been granted to operate the aircraft up to 40,000' provided the following conditions are complied with :-

(1) The captain's mask is stowed with safety pressure permanently selected ON.

(2) All crew members tighten their safety straps after masks have been donned following cabin pressure failure.

(3) Above 35,000' safety pressure is selected on the co-pilot's mask in lieu of the captain's, whenever the latter is absent from the flight deck.

Contd.

To complete the normal in situ check out procedure in the case of the captain's mask it will be necessary to temporarily select safety pressure OFF. This is best achieved by opening the right hand door of the stowage and turning the safety pressure button using one finger of each hand.

Aircraft fitted with improved masks are certified to operate to 40,000' without adopting the special procedures previously outlined.

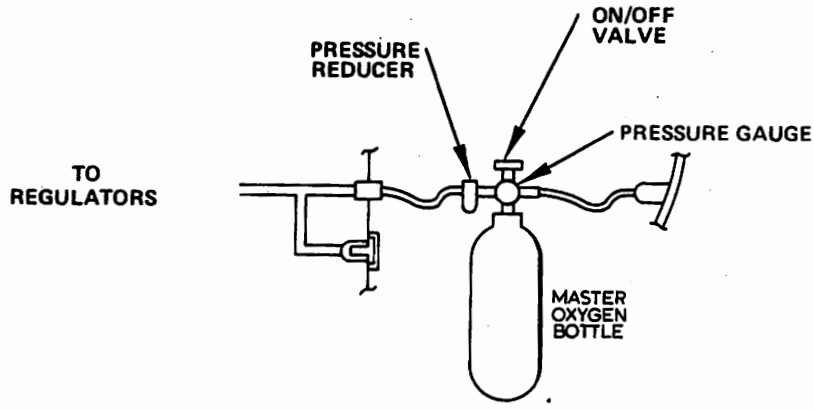
Improved masks will be identified by a yellow spot painted on the front of the mask adjacent to the oxygen supply tube. This will be visible even when the mask is stowed.

All L.1011 aircraft are scheduled to be modified by the end of December.

ETS.6/204512/EDG
22nd October, 1974

OXYGEN

CREW FIXED SYSTEM

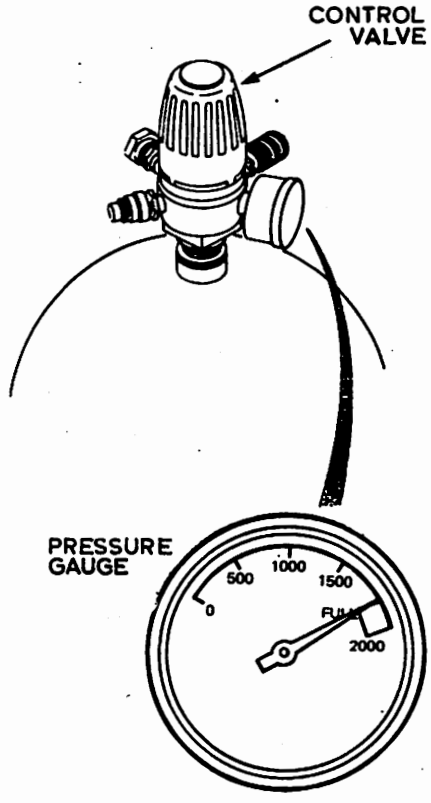


DESCRIPTION Gaseous oxygen is available for the flight crew and is supplied from a master bottle to the regulators of five EROS type masks located adjacent to the pilot stations.

CONTROLS AND INDICATORS

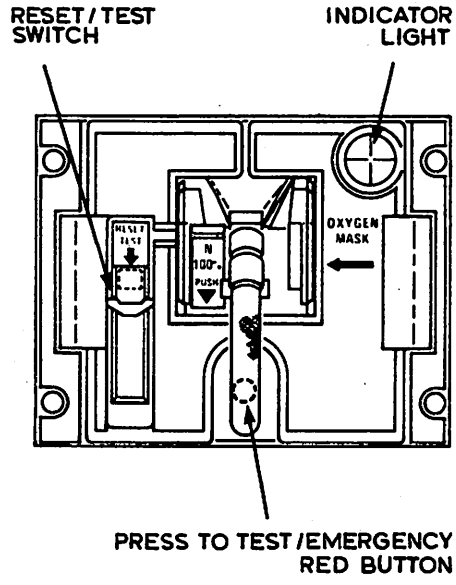
OXYGEN CYLINDER

Location	Outboard of P2
Pressure Gauge	When full, the pressure gauge will indicate 1800 psi.
Pre-flight acceptance	1400 psi ($\frac{3}{4}$ full) or above.
Control Valve	Normally the bottle should be selected ON.



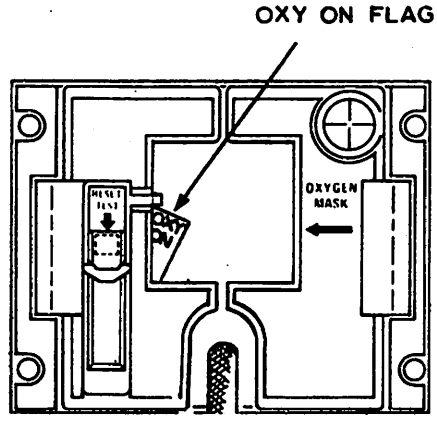
OXYGEN MASK STOWAGE BOX (MASK STOWED)

Location	Beside each crew seat
Indicator light	When mask is removed and oxygen is flowing indicator will illuminate.
RESET/TEST switch	Enables in situ testing of system without removing mask from stowage. When operated a white square is exposed.
PRESS TO TEST/EMERGENCY red button	With mask stowed oxygen flow can be tested by pressing in the red button provided the RESET/TEST switch is operated.



OXYGEN MASK STOWAGE BOX (MASK REMOVED)

OXY ON flag	When mask is removed and stowage doors are closed, OXY ON flag indicates that oxygen is available to the mask.

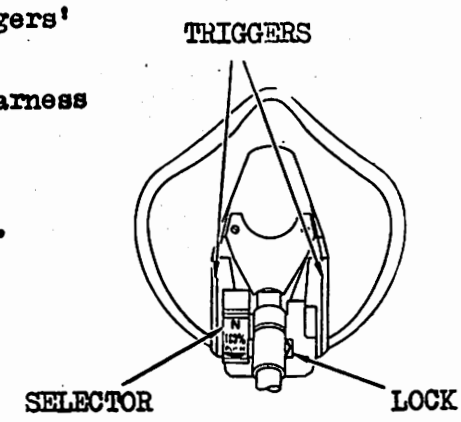


OXYGEN MASKS

Triggers

The masks are removed from the units by squeezing the 'triggers' and pulling out.

As the mask is removed the harness will fully inflate. When the 'triggers' are released the harness will conform to the wearer's cranium profile.



Selector

A sliding switch which selects diluted or 100% oxygen. It should be left in the NORMAL 'up' position.

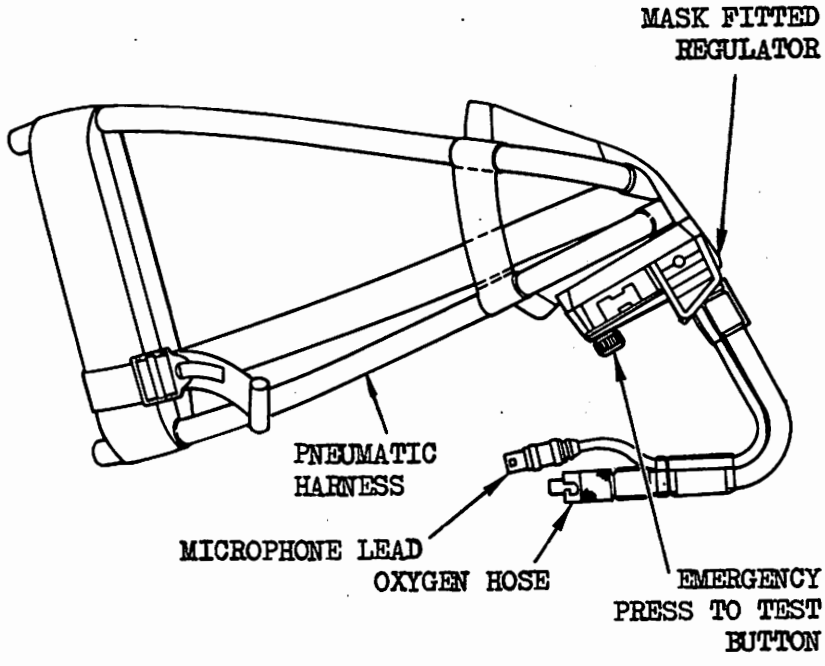
Duration

2 hrs.30 mins for the following conditions:-

i. Selector switch to NORMAL.
ii. All 5 masks in use.
iii. Cabin altitude 14,000 ft.

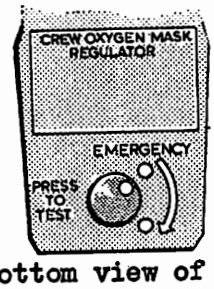
As cabin altitude rises above 14,000 ft. oxygen supply will automatically increase to 100% oxygen at 25,000 ft.

Side view



EMERGENCY/ PRESS TO TEST RED BUTTON

With oxygen mask donned a continuous flow of oxygen slightly above ambient pressure can be supplied for emergency purposes by pressing the red button IN and rotating it clockwise. The button will lock IN.



Bottom view of Regulator unit

IN SITU TEST SEQUENCE

1. Check contents gauge correct and master bottle selector to ON.

2. To check oxygen is available to mask regulator of mask being tested :-

   i. Push and hold down RESET/TEST switch to expose white square.
   ii. Note if indicator light gives a short 'blink'.

3. Squeeze mask triggers.

   i. RESET/TEST switch will allow oxygen to by-pass regulator and inflate harness.
   ii. Indicator light should blink and then extinguish, confirming that harness is leak proof.
   (If indicator light remains on - harness is leaking)

4. Release mask triggers.

5. Press in PRESS TO TEST/EMERGENCY red button. Indicator light should illuminate and remain on as long as button is kept pressed.
   (If indicator light fails to remain on - oxygen is not flowing)

6. Release RESET/TEST switch and PRESS TO TEST/EMERGENCY button. Mask container and head harness will empty of oxygen.

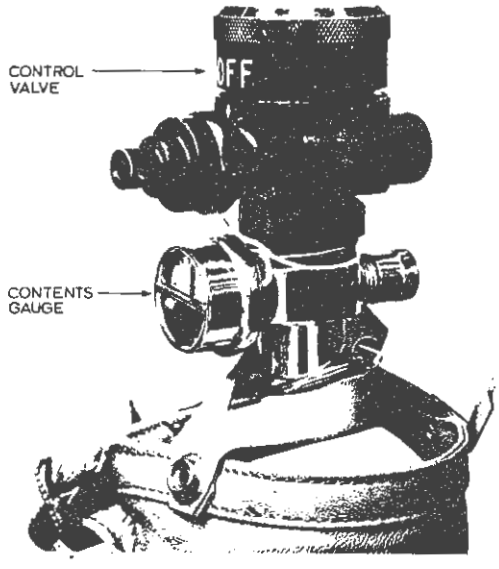
PORTABLE OXYGEN FOR SMOKE MASK

A 310 litre portable bottle is located adjacent to P5 seat below coat closet.

The bottle is fitted with a contents gauge and control valve which is turned clockwise to turn on oxygen.

Bottle duration

Minimum of 10 minutes.



PASSENGER FIXED OXYGEN

Description

The passenger system consists of chemical generator units stowed in the cabin roof.

Oxygen is delivered from the generators to masks located in overhead units, a mask being provided for every passenger seat plus an extra single mask in every other centre group to meet the FAA requirement of an extra 10%.

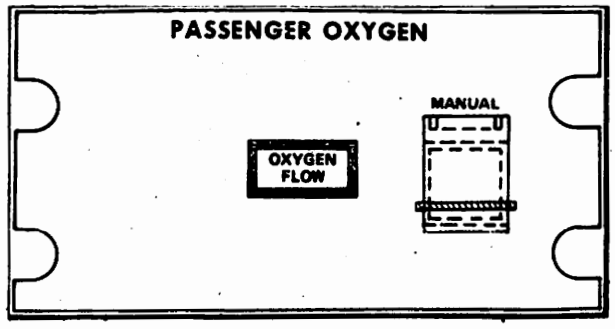
The generators are initiated and the masks drop out if the cabin altitude exceeds 13,000 ft.

Drop-out can be initiated manually.

System duration is 18 minutes, a mask flow indicator showing red when flow is low.

To comply with current ANO requirements an additional mask is located at each outboard seat row, except the last seat row. These can be removed by cabin crew after drop-out to provide oxygen for 15% of passengers for 30 minutes.

CONTROLS AND INDICATORS
(Upper Systems Station)



OXYGEN FLOW LAMP

When drop-out occurs the green lamp illuminates.

To extinguish - Interrupt electrical circuit via circuit breakers 1L15,1L16,1L17,1L18.

MANUAL switch

If manual deployment is required, the guard must be lifted and the switch depressed for 16 seconds.

This allows two full cycles of the release system.

PORTABLE OXYGEN

Description

A completely self contained portable oxygen system utilizing solid state oxygen generators which provide immediate oxygen availability without high pressure storage.

Single Paks

12 Paks located at cabin crew stations for use after decompression.

These will provide each cabin crew member with 4 litres of oxygen per minute for a minimum period of 20 minutes.

DuO-Paks

4 Paks located at L1, R1,L3 and R3 cabin crew stations for decompression and therapeutic use.

Each Pak will provide:-

4 litres per minute for 40 minutes

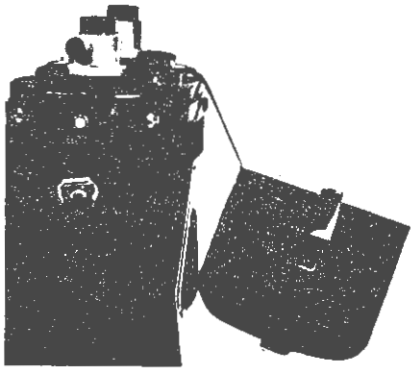
or

8 litres per minute for 20 minutes.

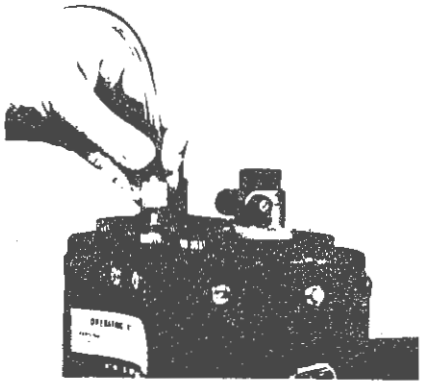
OPERATING INSTRUCTIONS

OPERATING INSTRUCTIONS

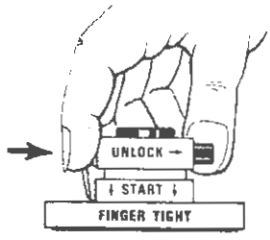
1. REMOVE THE COVER AND MASK ASSEMBLY. DO NOT REPLACE THE COVER WHILE THE UNIT IS OPERATING.



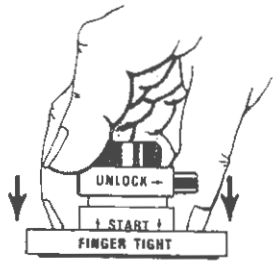
2. INSERT THE MASK ASSEMBLY CONNECTOR INTO THE OUTLET, IF IT WAS NOT PREVIOUSLY DONE.



3. UNLOCK THE ACTUATOR BY PRESSING THE GREEN BUTTON ALL THE WAY IN.



4. START THE OXYGEN GENERATOR BY PRESSING THE GREEN COLLAR DOWN IN THE DIRECTION OF THE ARROW.



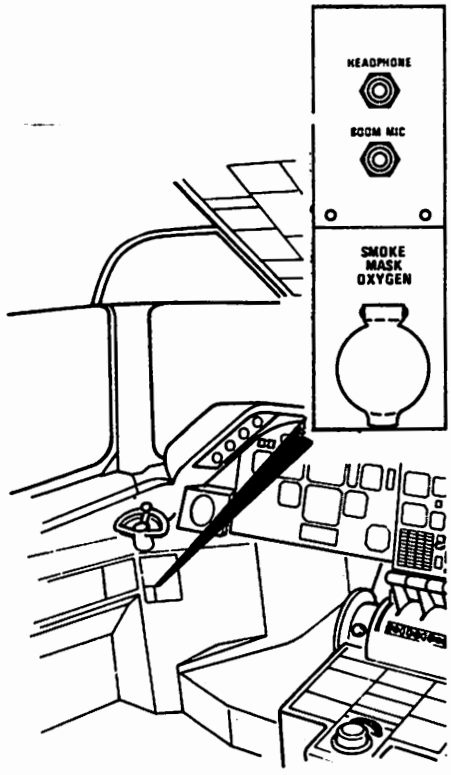
5. CHECK THE VISUAL FLOW INDICATOR LOCATED IN THE MASK HOSE LINE. THE RED FLOAT WILL DISAPPEAR WHEN OXYGEN FLOW IS STARTED AND WILL REAPPEAR WHEN FLOW STOPS.
6. PUT ON THE MASK ASSEMBLY AND BREATHE NORMALLY.
7. IF OXYGEN FAILS TO FLOW IN A DUO-PAK AFTER ACTUATION, START THE SECOND GENERATOR. REMOVE THE ACTUATOR AND RESET AS PREVIOUSLY DESCRIBED.
8. IF OXYGEN FAILS TO FLOW IN A SINGLE-PAK, REMOVE THE ACTUATOR, RESET AND RESTART.

SMOKE PROTECTION

Three smoke masks and two pairs of smoke goggles are located in a stowage below P4 seat.

The masks can be plugged into outlets at :-

1. Captain and P2 EROS oxygen mask units.
2. Adjacent to P3 oxygen mask unit.
3. 310 litre portable oxygen bottle.



TEMPORARY SMOKE PROTECTION FACILITY

Pending delivery of the special smoke masks required for the TriStar, Modification 25A612 introduces :-

i. 3 additional pairs of smoke goggles

ii. 1 Comet type smoke mask to be used in conjunction with the 310 litre portable oxygen bottle.

iii. Air mix selector on the EROS oxygen mask to be set to the 100% position.

In the event of smoke entering the flight deck ALL crew members must don their oxygen masks and smoke goggles.

The portable cylinder and smoke mask are to be used for remote fire fighting.

POWER PLANT AND FUEL

CONTENTS

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GENERAL

Rating

The RB-211-22B is rated to give 42,000 lb. thrust (nominal) up to ISA + 13.9°C.

Leading Particulars

The engine is a three shaft, high by-pass ratio turbo fan engine. It comprises a single stage fan mounted on a separate shaft driven by a two shaft gas generator. Engine thrust is produced from two separate streams:-

Airflow from the fan	-	termed the cold stream.
The exhaust from the gas generator	-	termed the hot stream.
Air intake	-	8 feet dia. approx.
Engine length	-	14 feet.
Weight	-	8,400 lb. (basic dry conditions)
Low Pressure section of engine.	-	single L.P. stage (fan) driven by 3 stage turbine.
Intermediate Pressure section of engine.	-	7 stage axial flow driven by single stage turbine.
High pressure section of engine.	-	6 stage axial flow driven by single stage turbine.
By-pass ratio	-	5 : 1
Overall pressure ratio	-	27 : 1 at design cruise.

D.O.R. as normal anti-clockwise viewed from the rear!

Mechanical Arrangement

The engine is in seven basic parts called modules. This simplifies engine maintenance work (a module can be changed in-situ); the modules are:-

Low pressure compressor rotor.
Intermediate pressure compressor rotor.
Intermediate casing.
High pressure compressor system.
Intermediate and low pressure turbine.
External high speed gearbox.
Low pressure compressor casing.

See Power Plant 5 for mechanical arrangement. Only the location of the external gearbox is significant because the oil replenishment points are located on the gearbox.

The No.2. (centre engine) is identical to the wing engines with minor installation differences; the air intake is a 'swan neck' duct similar to the Trident aircraft.

Operation

The engine is designed to:-

Operate with improved economy particularly at cruise conditions.

Provide flat rated thrust at all altitudes over a wide temperature range.

The improved economy is obtained by:-

Imparting a lower acceleration to a large mass of air.

Employing high pressure ratios across the engine compressor.

Using high turbine temperatures.

The fan produces 75% of the total thrust at take-off and the gas generator 25%. These are approximate figures.

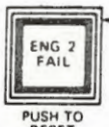
To provide maximum compressor efficiency the three rotating assemblies each have their own R.P.M. range. However, the R.P.M. differentials produced will not be constant varying with throttle lever position and air intake temperature.

Compressor air flow control is fully automatic with no flight deck controls or indicators. Control is by four bleed valves fitted to the compressor system together with a set of Variable Inlet Guide Vanes (V.I.G.V.s) at the inlet to the Intermediate Compressor.

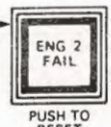
An annular combustion system fitted with 18 burners, two of which have an igniter plug alongside, provides the high energy gas stream for the turbines.

The reverser system mechanically blanks off the fan exit nozzle and re-directs the fan thrust forward. The 'hot stream' gas from the jet pipe is not directed forward but it is simply neutralised by two doors moving across the exit into the jet stream. This arrangement is applicable to all three engines.

ENGINE INSTRUMENTS (CENTRE INST. PANEL)



ENGINE NO 2 FAIL LIGHTS (GLARESHIELDS)
Illuminates to indicate No 2 engine failure while aircraft is on the ground during takeoff.

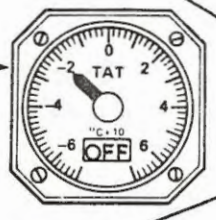


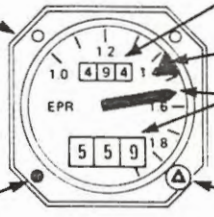
ENGINE PRESSURE RATIO INDICATOR (3)
Indicates ratio of integrated exhaust pressure to Air intake pressure. Indicated value is proportional to thrust output.
Primary thrust setting instrument.

SET COUNTER
Indicates EPR bug position set by knob.

EPR BUG
Positioned by EPR set knob.

TAT INDICATOR
Indicates total air temperature. OFF flag appears with power loss, system failure or failure of TAT indicator.





EPR POINTER/COUNTER
Pointer indicates gross engine EPR. Counter indicates fine engine EPR. Counter red warning flag appears with no electrical power or transmitter signal is driving the pointer against its Max. or Min. stop.

TEST BUTTON
On pressing, pointer should read 1.3 units.

EPR SET KNOB
Positions EPR bug and numerical value in set counter.

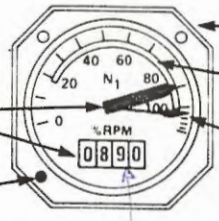
MAX INDICATOR RESET SWITCH
Momentary action switch that resets overspeed pointers

N_1 R.P.M. INDICATOR (3)
Indicates % of RPM of the fan (LP) compressor.
Secondary thrust setting instrument.

RANGE MARKS

Green	18- 99.5%
Yellow	99.5 - 101%
Red Radial	101%

N_1 POINTER/COUNTER
Pointer indicates gross N_1 rpm. Counter indicates fine N_1 rpm. Counter flag drops when indicator fails.



N_1 OVERSPEED POINTER (3)
Indicates and remains at overspeed rpm reached.
Reset by using the max indicator reset switch.
101% NOMINAL.

TEST BUTTON
Pressing pushbutton tests system and indicator.
Pointer drives to 12 o'clock position to indicate normal operation.

RED BAR "POWER OFF"

TURBINE GAS TEMPERATURE INDICATOR (TGT) (3)
Indicates temperature of exhaust gas entering LP 1 nozzle guide vanes.

RANGE MARKS

Green	300 - 700 °C
Yellow	700 - 738
Red Radial	738

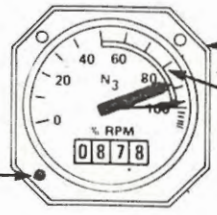
TGT POINTER/COUNTER
Pointer indicates gross TGT.
Counter indicates fine TGT. Counter flag drops when indicator fails.

OVER TEMPERATURE POINTER
Indicates and remains at overtemp reached.
Reset using max indicator reset switch.

T.G.T. OVERHEAT LIGHT (RED)
Illuminates when the indicated temperature reaches 750°C.
Extinguishes as temperature decreases below 705°C.

TEST BUTTON
Pressing pushbutton tests system and indicator.
Pointer drives to 12 o'clock position to indicate normal operation.

RED BAR "POWER OFF"



N_3 R.P.M. INDICATOR (3)
Indicates rpm at high pressure compressor.
The N_3 pointer/counter and overspeed pointer operates the same as for N_1 tachometer

RANGE MARKS

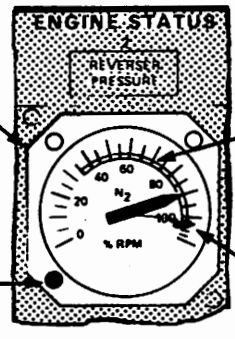
Green	50 - 93.7%
Yellow	93.7 - 95%
Red Radial	95%

TEST BUTTON
Pressing pushbutton tests system and indicator.
Pointer drives to 12 o'clock position to indicate normal operation.

FUEL FLOW INDICATOR (3)
Indicates kilograms per hour rate of metered fuel delivered to the engine.

ENGINE INSTRUMENTS
(ENGINE STATUS PANEL - SYSTEMS STATION)

N_2 R.P.M. INDICATOR (3)
Indicates % RPM of intermediate pressure compressor.

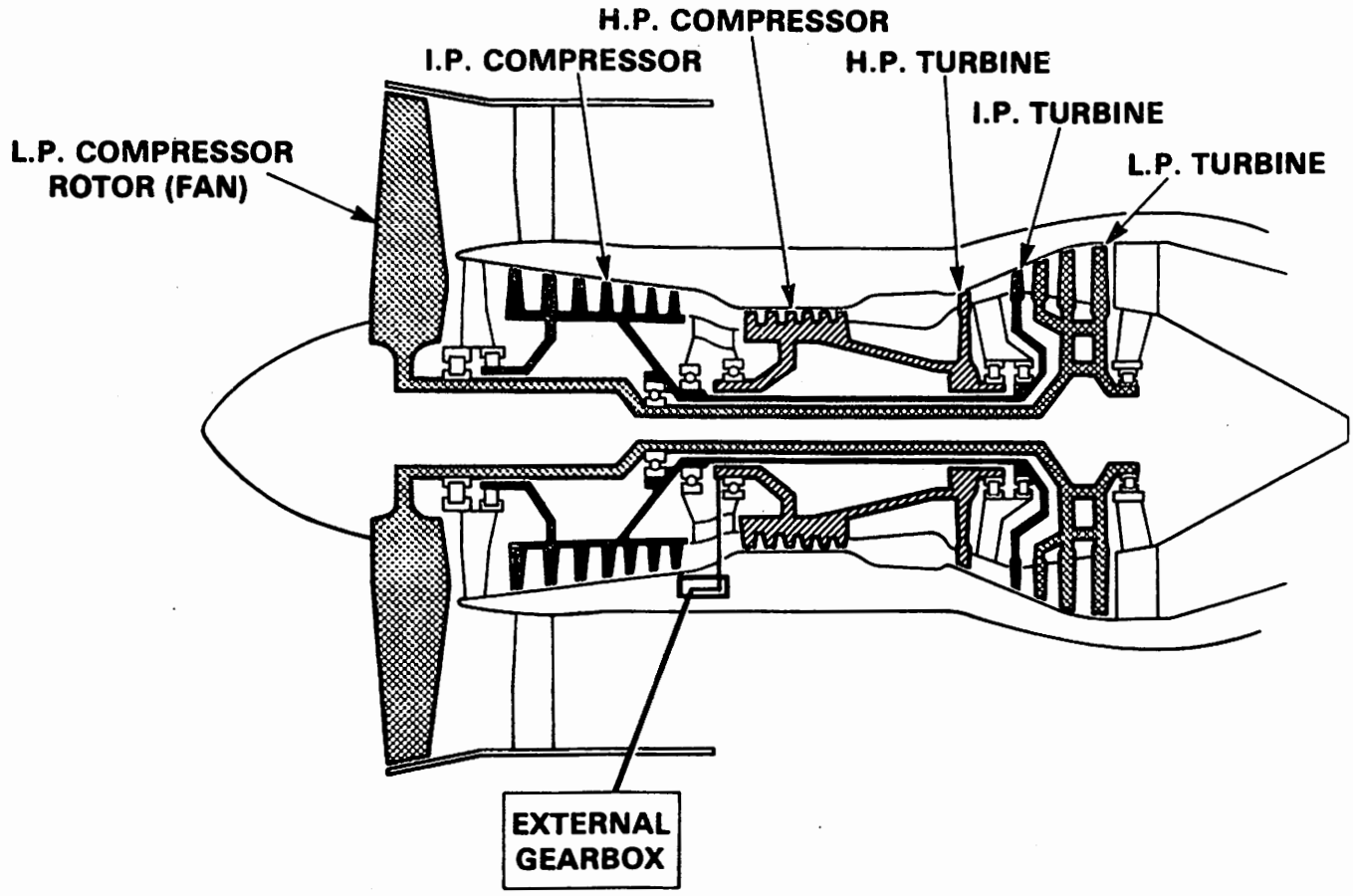


RANGE MARKS
Green - 35 - 97%
Yellow - 97 - 98.1%
Red Radial - 98.1%

N_2 R.P.M. INDICATOR TEST BUTTON
Holding pushbutton switch IN tests indicator by driving pointer to the 12 o'clock position.

OVERSPEED POINTER

MECHANICAL ARRANGEMENT



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OIL SYSTEM

GENERAL

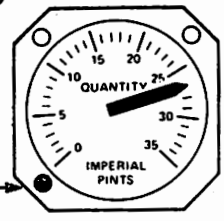
The oil system is of the self contained full flow re-circulatory type and provides lubrication and cooling for the bearings, gears and splines. A schematic of the system is included at the back of this section. The oil tank is integral with the external gearbox on the left hand side of the engine.

INDICATIONS

Oil quantity, temperature and pressure are displayed for each engine on conventional instruments located on the Engine Oil Panel at the P_3 Systems Station.

Oil Contents Gauges

Indicates usable oil remaining in the engine oil tank.



Testing (B.I.T.E.)

Test switch - a momentary push button switch which drives the pointer to 12 o'clock position.

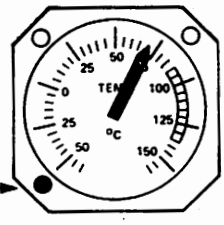
Oil Contents Gauges

Loss or change in oil level indication monitor oil pressure and temperature. During starts under cold soak sub-zero temperature conditions, oil pressure rises to full scale (100 psi) and indicated oil quantity may fall to zero. As oil temperature rises with the engine at idle conditions, oil pressure will fall and indicated oil quantity will return to normal. The engine should not be accelerated from idle until the oil quantity starts to rise and the oil temperature is above - 10°C.

Oil Temperature Gauge

Indicates oil temperature after it passes through the filter.

Range Marks - Yellow 90° - 135°C
Red Radial 135°C



Testing (B.I.T.E.)

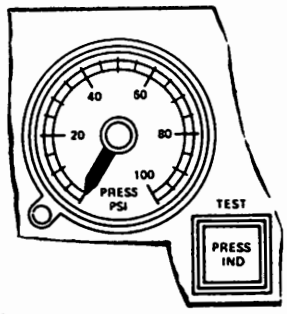
Test Switch - a momentary pushbutton switch that drives the pointer to the 12 o'clock position.

Oil Temperature Gauges (3)

Large reductions in R.P.M. may produce transient increases in oil temperature. This is acceptable provided the maximum temperature does not exceed 135°C and the period above 100°C does not exceed 15 minutes.

OIL PRESSURE GAUGES

Indicates oil pressure in oil distribution system.



Testing (B.I.T.E.)

A separate momentary push-button switch that drives the pointer to the 9 o'clock position.

Range Marks - Orange 0 - 35 p.s.i.
Yellow 35 - 40 p.s.i.
Green 40 - 100 p.s.i.

Oil Pressure Gauges

Oil pressure is affected by R.P.M. and temperature. Normally, the oil pressure at Maximum Continuous and Take-off is greater than at Ground Idle or Flight Idle and is approximately constant from maximum continuous to take-off. An average pressure would be 60 - 80 p.s.i. During engine acceleration oil pressure may tend to decrease above 75% N_3.

If oil pressure increases rapidly, check oil quantity. If increasing, shut down the engine. Increased oil quantity may be caused by a fuel leak in the fuel/oil heater.

Oil Pressure Warnings

M.W.S.

Low oil pressure (18 p.s.i.)

'OIL PRESSURE ENG' (No. 1, 2 or 3) will illuminate. Reference to the oil pressure gauge should confirm this, if the oil pressure is below flight limit, shut down the engine.

Filter Pressure Light

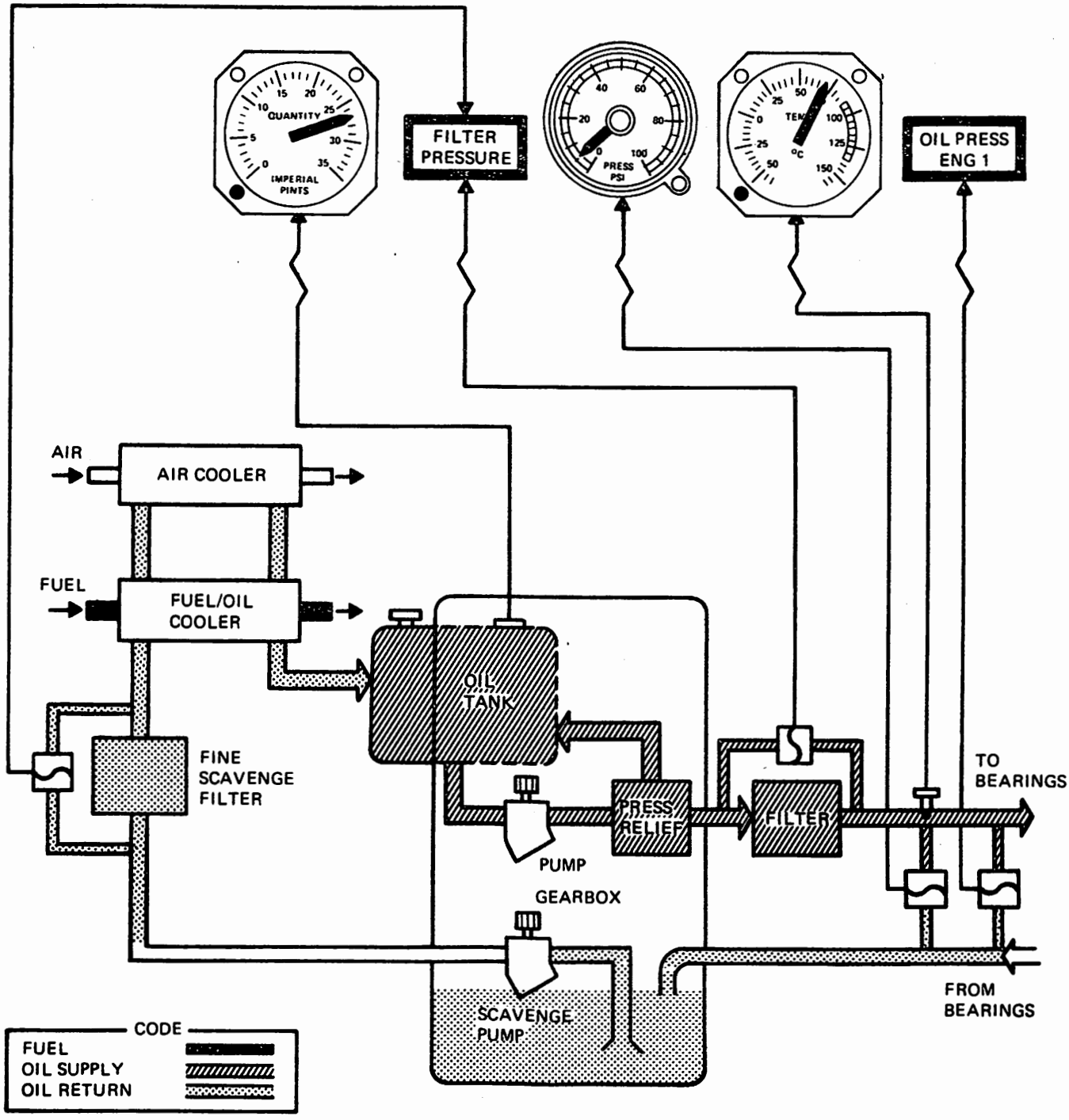
FILTER PRESSURE is illuminated when the oil pressure filter is becoming blocked.

M.W.S.

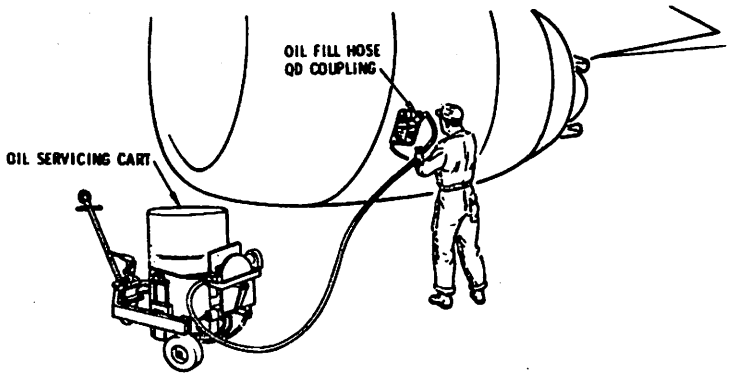
Oil pressure filter high differential pressure

This could indicate impending engine failure. Continued operation is permitted provided other engine indications are normal. If not, shut down the engine.

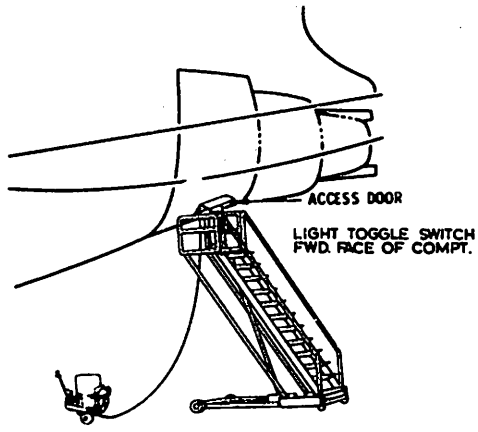
ENGINE OIL SYSTEM



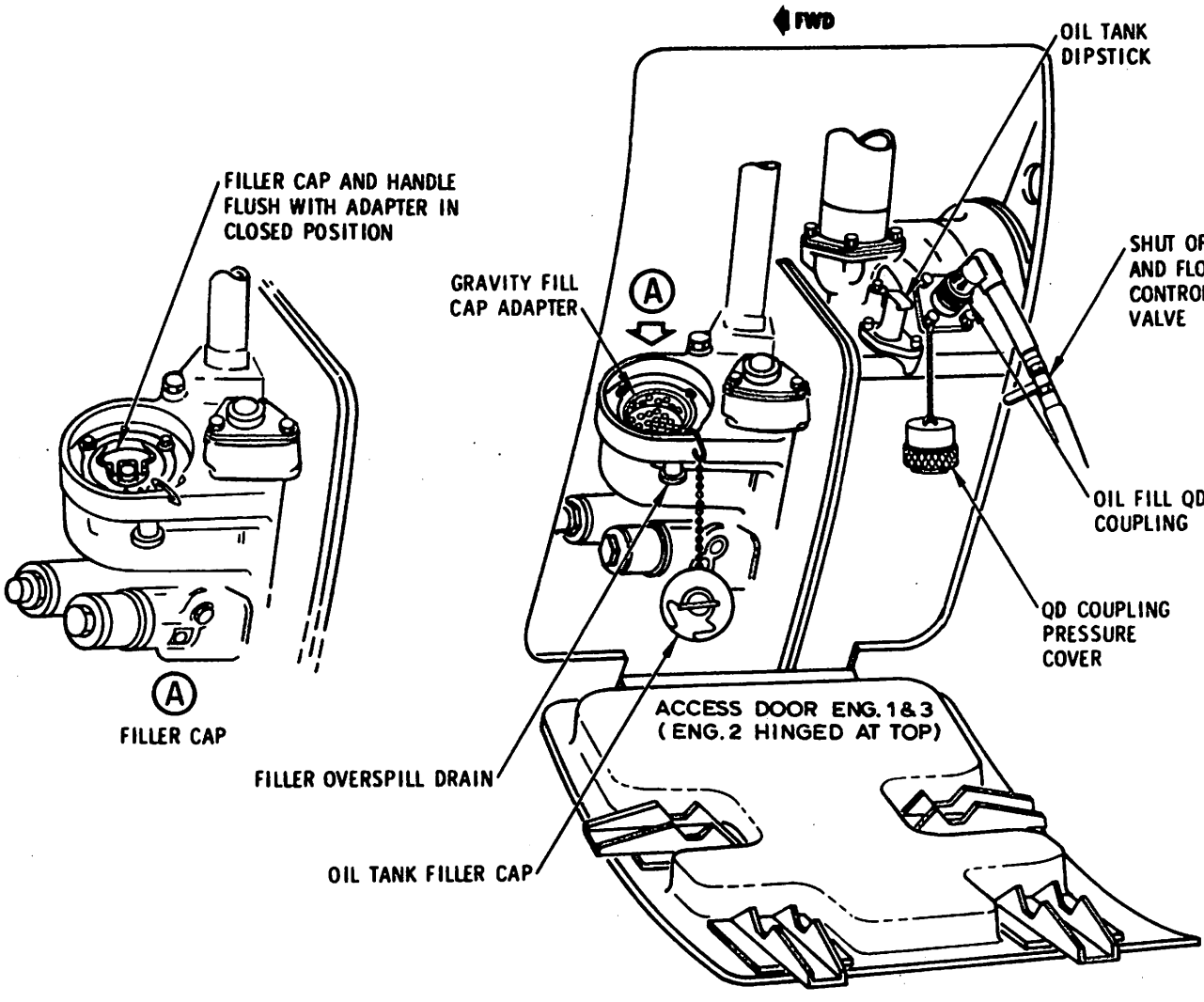
OIL REPLENISHING



ENGINES No.1 and 3



ENGINE No. 2



REPLENISHMENT

Access to the oil tank is through a small door on the left hand side of the cowling. It can be replenished through a quick release coupling for pressure filling or by gravity filling through a separate conventional filler cap.

If oil is visible at the bottom of the strainer when the filler cap is removed, then the oil level is satisfactory and no replenishment is required.

Access to No.2. engine for oil replenishment is through a door on the underside of the rear fuselage. There is a light which can be switched on from a toggle switch on the forward left hand side. Also see Power Plant 10

Check after 15 minutes but not later than 30 minutes.

Capacities	Total System	- 60 pts
	Oil Tank	- 36 pts (approx)
	Usable Oil	- 25 pts
	Max Consumption	- 2 pts/hr.
	Dipstick	- graduated in 'pts to fill'

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AIRCRAFT FUEL SYSTEM

GENERAL

The fuel system consists of four integral wing tanks which operate as a three tank system. The inboard tanks (No.1. and 3) supply No.1. and 3 engines respectively. The outboard tanks are manifolded together through a flow equaliser to supply No.2. engine. Wing stress relieving is achieved by dividing the outboard tank into two compartments which are connected together by an automatic float-valve. Only the inboard compartment supplies fuel until 450 kgs. remain then the float-valve opens and fuel flows from the outboard compartment into the inboard.

Vent System

The fuel tanks in each wing are vented to atmosphere via a vent collector tank located outboard of the No.2. tank in the wing tip. The vent collector tank has two vents, a main standpipe and a standby auxiliary vent.

Fuel passing through the vent lines will collect in the vent tank,'jet pumps' operated by the No.2. tank booster pumps will scavenge the fuel back to the No.2. tank.

Scavenge System

The booster pumps are fitted in surge boxes to ensure that the pumps are immersed in fuel at all times. Jet pumps operated by the motive flow from the booster pumps scavenge fuel from the low points within the tank. This fuel is pumped to the surge boxes so that any settled water will be dispersed, fed and then consumed by the engines.

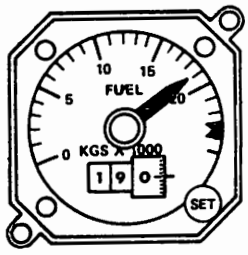
CONTROLS AND INDICATORS

The controls and indicators are located on the Fuel System panel at the P_3 Systems Station. See Power Plant 20 for layout and presentation.

FUEL CONTENTS

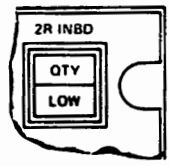
FUEL CONTENTS GAUGES (4)

Indicates individual tank fuel contents. Set-knob - sets the bug.



FUEL LOW/QUANTITY INDICATOR SWITCH (2)

IN - QTY is illuminated and the associated No.2. tank fuel contents gauge shows the fuel contents of the No.2. tank <u>inboard</u> compartment.

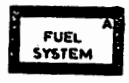


OUT - QTY is extinguished and the associated No.2. tank shows the <u>total</u> fuel contents of the No.2. tank.

LOW - (amber) is illuminated any time (i.e. whether switch is latched in or out) the fuel contents in the inboard compartment of No.2. tank is below 320 kgs.

FUEL QUANTITY TEST SWITCH (B.I.T.E.)

Pressing switch drives all the fuel contents gauge indicators towards "full" and illuminates the Low legend in the 2L and 2R Fuel Low/Quantity Indicator switches and the M.W.S. FUEL SYSTEM.

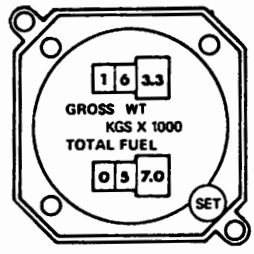
Associated amber M.W.S. 

NOTE:

Do not press test switch whilst refuelling is in progress as refuelling may be cancelled.

TOTAL FUEL QUANTITY INDICATOR (1)

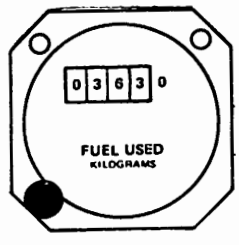
Top window indicates aircraft gross weight. Bottom window indicates total fuel contents.



Gross Weight Set Knob - rotary knob that sets initial gross weight, thereafter readout is automatic.

FUEL USED INDICATORS (3)

Located on the "Engine Fuel Panel" adjacent to the Fuel System panel. Window displays fuel used in kgs/hr.



Test knob spring loaded. Rotated clockwise - checks fuel flow rate and fuel used circuits.

(i) The associated engine fuel flow indicator on the pilot's centre instrument panel will read 4,500 kgs/hr.

(ii) Fuel used indicators drive at a rate of 4,500 kgs/hr.

Rotated anti-clockwise - checks only the indicators.

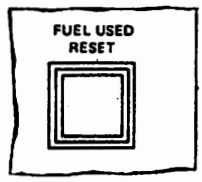
(i) Associated fuel flow indicator reads 4,500 kgs/hr.

(ii) Fuel used indicator is driven at a rate of 4,500 kgs/hr.

RESETTING

FUEL USED RESET SWITCH

Momentary switch pressed to reset Fuel Used Indicators.

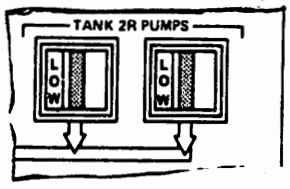


FUEL FEED SYSTEM

TANK (BOOSTER) PUMP SWITCHES (8)

IN - White flowbar illuminates indicating switch position and the pump is switched on.

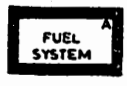
OUT - Flowbar is extinguished and the pump stops.



LOW - is illuminated when the pump output pressure is below minimum.

The light will blink momentarily when the pump is initially switched on.

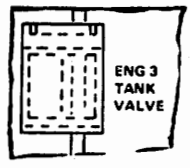
Associated amber MWS.



ENGINE TANK VALVE SWITCH (3)

IN - White flowbar illuminates indicating switch position. Blue in transit light illuminates indicating disagreement between switch position and valve position.

OUT - Flow bar extinguished, blue in transit light on until valve closes then goes out.

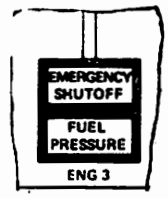


NOTE:

1. One exception to the above is that when the Fire Pull handle is pulled the white flow bar extinguishes even with the switch latched in.
2. No.2. Engine Tank Valve is not closed when its Fire Pull Handle is pulled. This allows the No.2. Engine Fuel system to supply the A.P.U. if required.

EMERGENCY SHUT-OFF VALVE (4)

The purpose of the Emergency Shut-off Valve is to isolate the aircraft fuel supply from the engine after a Fire Drill (equivalent to the British L.P. Cock).



Emergency Shutoff - is illuminated when the valve is in transit or when in disagreement with the Fire Pull handle position.

No.2. engine has two of these valves fitted in series.

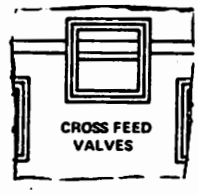
FUEL PRESSURE INDICATOR

Fuel Pressure - illuminated by low fuel pressure, the occasions when this lamp will come on are given in Power Plant Page 18.

Associated Amber MWS.

CROSS FEED VALVE (3)

Three Cross Feed Valves are fitted into the system to allow any or all tanks to feed fuel to any or all engines.



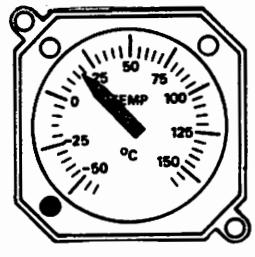
IN - White flowbar is illuminated indicating switch position. Blue in transit light illuminates indicating disagreement between switch position and valve position and goes out when valve is fully opened.

OUT - Flowbar extinguished blue in transit light on until valve is fully closed.

FUEL TEMPERATURE

FUEL TEMPERATURE GAUGE

Indicates tank 2L inbd. compartment fuel temperature or temperature of fuel at fuel filter outlet as selected with fuel temperature selector.

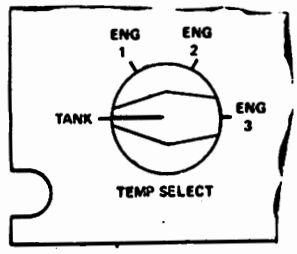


Testing (B.I.T.E.)

Fuel Temperature Test Switch - when pressed in, drives indicator pointer to 12 o'clock position.

FUEL TEMPERATURE SELECTOR SWITCH

Four position rotary switch that selects outboard tank 2L inbd. compartment fuel temperature or engine 1, 2, 3 fuel filter outlet temperature to be read on fuel temperature gauge.



ENGINE FUEL SYSTEM

GENERAL

The engine fuel system provides:-

Pilot control of engine thrust and ensures smooth acceleration and deceleration under all conditions.

Enable pilot selected fuel flow to be overridden if certain engine operating limitations are reached.

Control fuel to the combustion chamber for starting and stopping the engine.

The following is a brief description of the function of each component in the engine fuel system in order of fuel flow. Refer to POWER PLANT 22.

L.P. Fuel Supply

From the fuel tank, the fuel at booster pump pressure passes through two shut-off valves:-

1. Tank Valve.
2. Emergency Shut-off Valve.

No.2. Engine has two Emergency Shut-off Valves in series, a primary and a secondary.

Fire Pull Handle

Pulling an Engine Fire Pull Handle will automatically close the Emergency shut-off valves. Simultaneously, the Fire Pull Handle will close the Tank valve except on No.2. Engine.

Tank Valve

The operation of this valve is fully covered in Power Plant 15

Low Pressure Pump

The low pressure fuel pump ("backing pump") is an engine driven pump which maintains the fuel pressure at the inlet to the H.P. Fuel Pump, sufficient to prevent cavitation. It is an integral part of the H.P. Fuel Pump.

Fuel Cooled Oil Cooler

A conventional heat exchanger which cools engine oil and heats the fuel. This unit determines the oil and fuel temperature.

Fuel Flow Transmitter

Provides the signal to the Fuel Flow Indicator on the pilot's centre instrument panel.

Fuel Filter

Prevents contamination of the high pressure fuel system components. Fitted across the filter is a differential pressure switch to sense a blocked filter condition.

Low Pressure Fuel Switch

Downstream of the filter.

Fuel Pressure Warning

The Fuel Pressure Amber Light on the Fuel Panel at the P_3 systems station will illuminate when:-

1. Engine driven Low Pressure Fuel Pump output insufficient.

   or

2. Fuel Filter blocked.

   or

3. Engine not running and fuel booster pump OFF or failed.

Associated MWS.

Fuel Temperature Probe

A fuel temperature probe fitted close to the fuel filter senses fuel temperature and displays it on the Fuel Temperature Gauge. Also see Power Plant 22

High Pressure Fuel Pump

Delivers the required fuel flow to the combustion chamber as scheduled by the fuel flow regulator. A spill control valve within the pump returns excess pump output back to the inlet side of the pump.

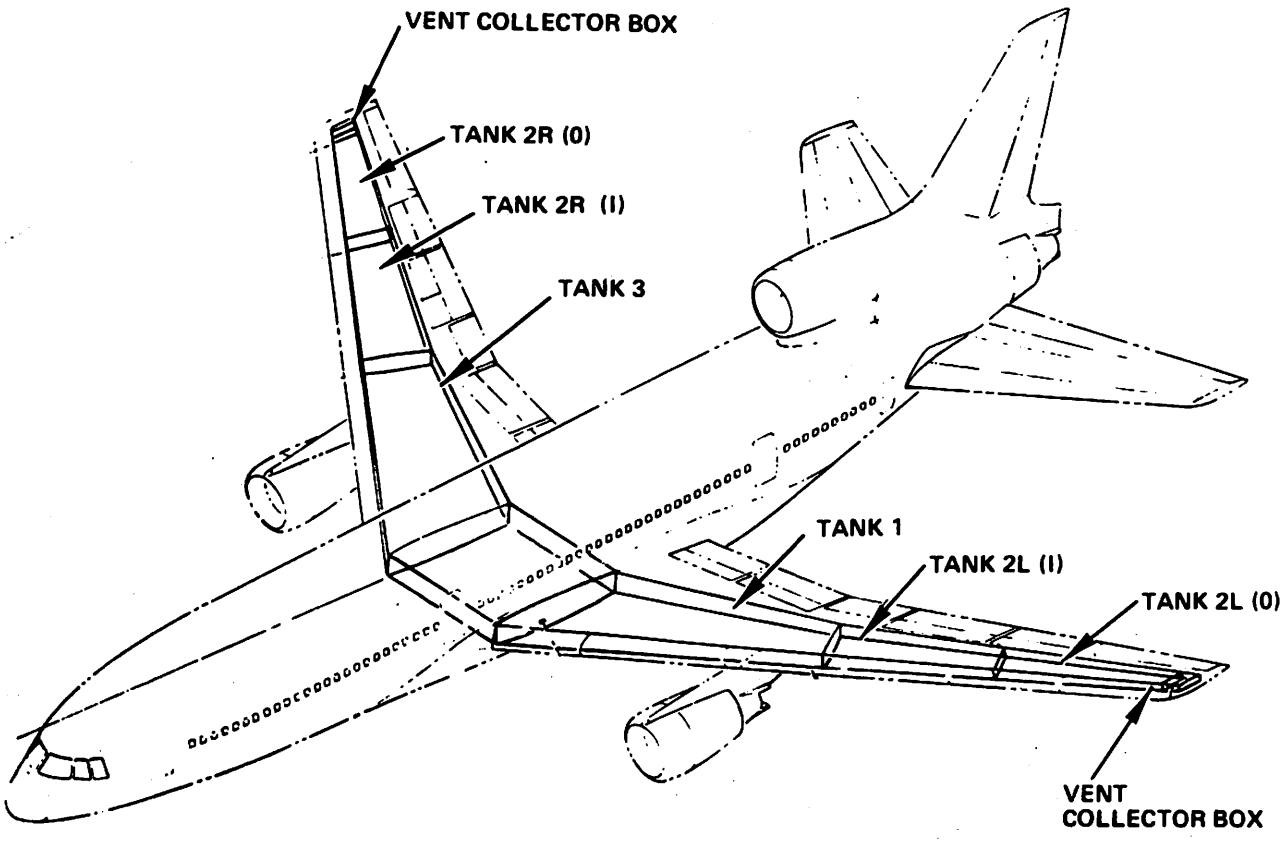
Fuel Flow Regulator

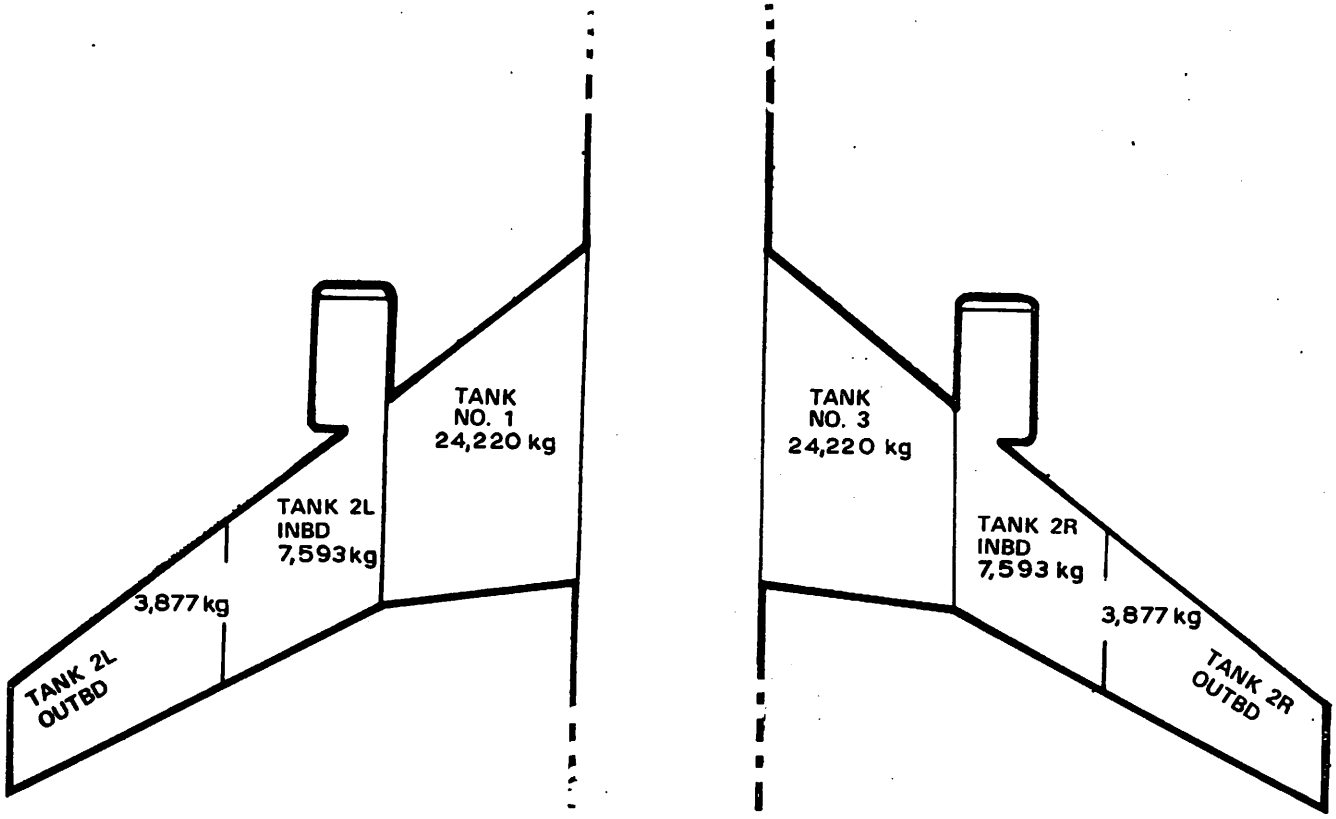
Controls the high pressure fuel pump output. A more detailed description is given later.

H.P. Shut-off Valve

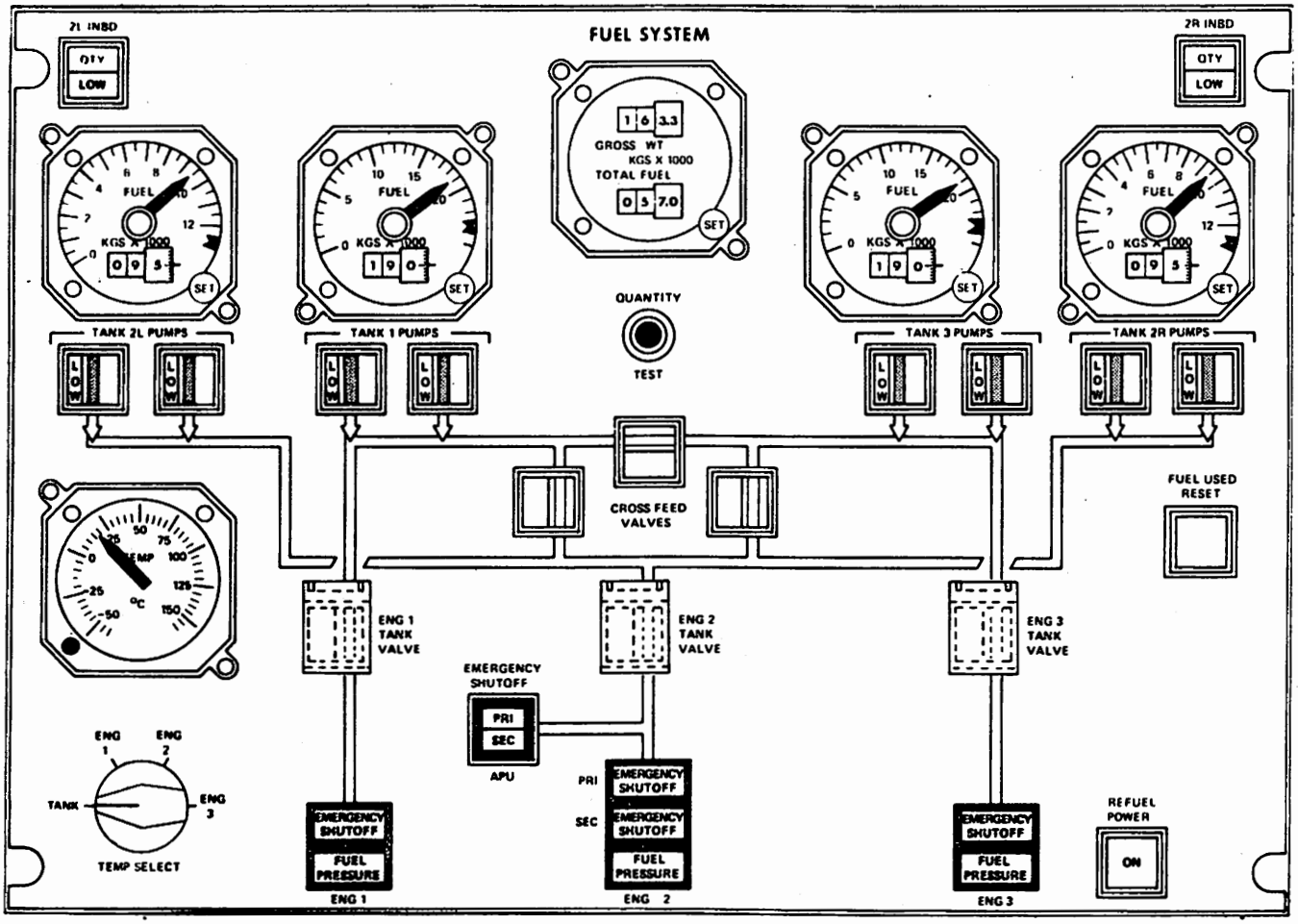
An electrically actuated two position H.P. cock which controls the fuel supply to the burners during starting and stopping the engine. When the valve is closed the burner manifold drains into the engine drain system. Control for the H.P. Shut-off valve is from the fuel and ignition switch on the centre control pedestal. Also refer to Power Plant 22 & 47

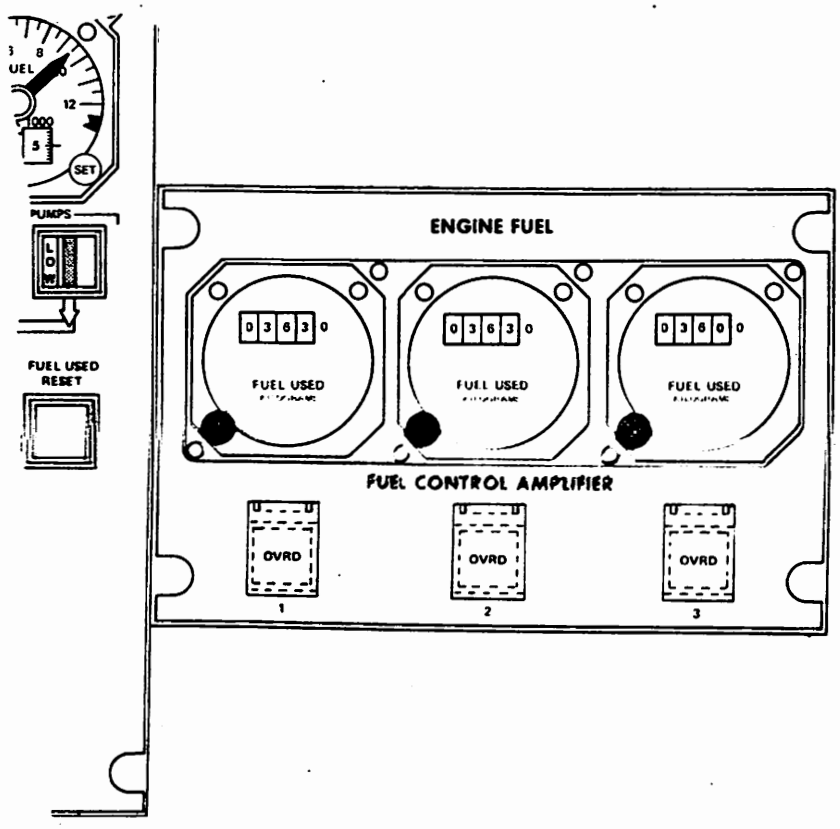
FUEL TANK ARRANGEMENT





FUEL PANEL (SYSTEMS STATION)





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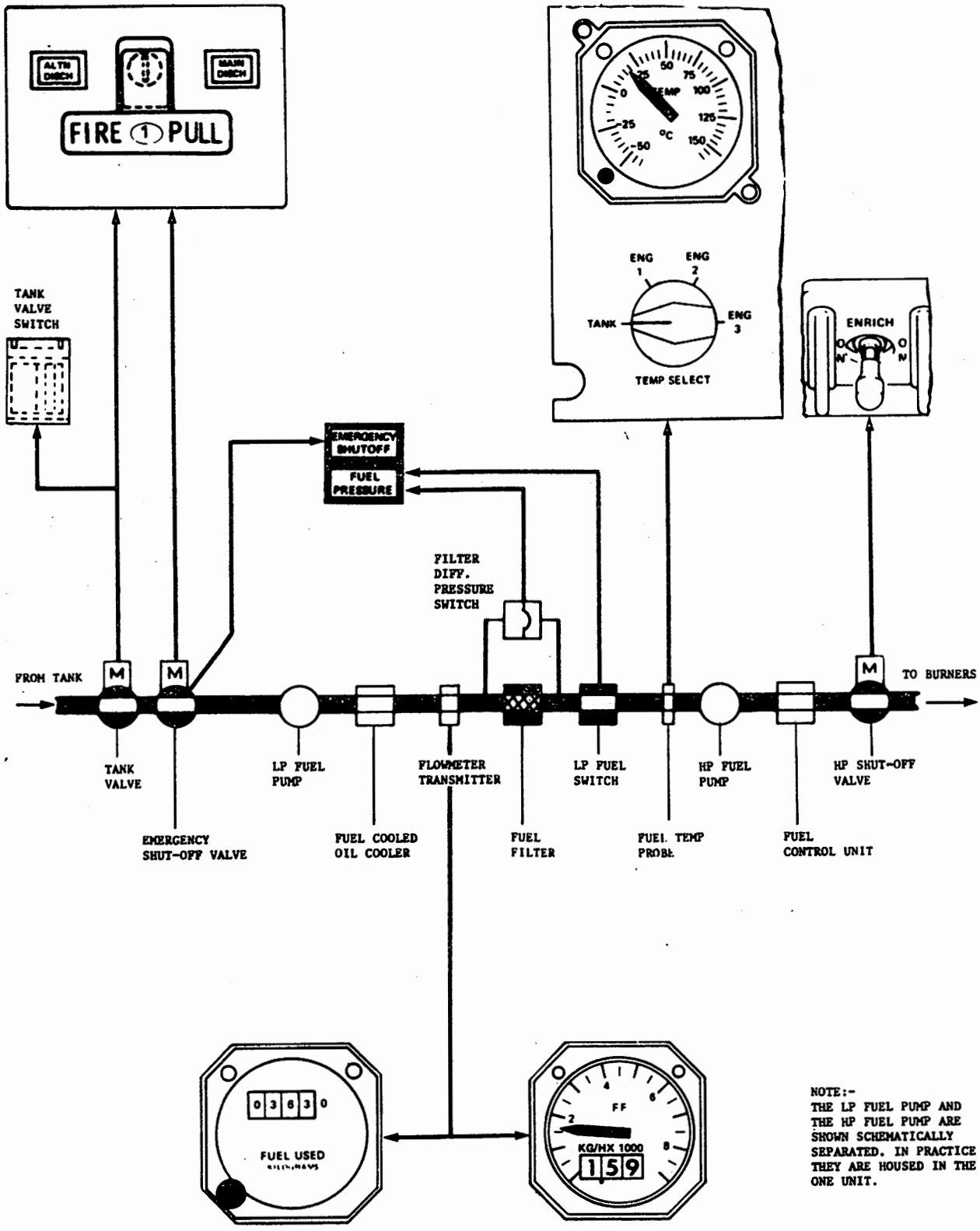


NOTE:-
THE LP FUEL PUMP AND THE HP FUEL PUMP ARE SHOWN SCHEMATICALLY SEPARATED. IN PRACTICE THEY ARE HOUSED IN THE ONE UNIT.

ENGINE FUEL CONTROL

Fuel Control Unit

The Fuel Control Unit (F.C.U.) consists of two components; a Pressure Ratio Control and a Fuel Flow Regulator.

The Pressure Ratio Control maintains the pressure ratio P_4/P_1 (thrust) selected by the pilots throttle lever. It does this by adjusting the fuel flow regulator.

The Fuel Flow Regulator is a variable datum hydro-mechanical governor driven by the H.P. Shaft. It controls the speed (N_3) of the H.P. compressor section of the engine.

The F.C.U. is thus able to adjust the output of the H.P. Fuel Pump to give the required fuel flow to maintain the selected P_4/P_1 ratio.

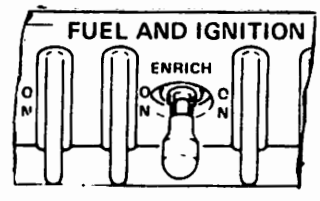
The relative R.P.M. of the three engine shafts will vary depending on climatic conditions.

A further input to the F.C.U. is an air ground sensing signal from the main undercarriage weight on circuits.

On the ground with the throttles between 35 and 65 degree angle, the fuel flow is reduced approximately 10%. The ground idle solenoid in the F.C.U. cannot be energised in flight. On the ground, the ground idle solenoid is de-energised when the throttles are advanced for take-off or when reverse thrust is selected.

FUEL AND IGNITION SWITCH "Enrich"

Holding the Fuel and Ignition switch up to the Enrich position will increase fuel flow to assist engine starting.



FUEL CONTROL AMPLIFIER

General

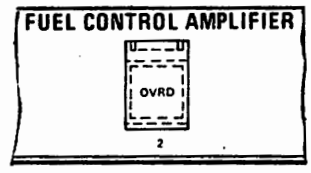
An overtemp/overspeed control system is provided for each engine for automatic limiting of T.G.T./R.P.M. during high thrust conditions. Each system consists of T.G.T. probes, fan (N_1) R.P.M. probes, a dual channel amplifier, an electrical actuator, flight deck control and test switches.

Operation

The fuel control amplifier reacts to overspeeds and/or overtemps by reducing fuel to the engine sufficiently to hold TGT or N_1 within limits.

Controls

Fuel Control Override Switches (3) located at the P_3 systems station Engine Fuel Panel are provided to override the amplifier in the event of an amplifier malfunction.



A guarded two position switch.

Normal position, OUT - OVRD is extinguished.

IN - OVRD is illuminated.

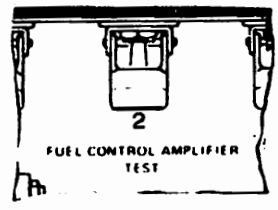
Automatic T.G.T. and N_1 limiting is removed.

With the control amplifier switch in the OVRD position overspeeds or overtemps must be controlled manually.

Testing

Fuel Control Amplifier Test Switches (3) located at the base of the centre control pedestal. Provided for maintenance engineers to test the amplifier on the ground.

Momentary toggle switches which when held in the up position, send a false signal to the N_1 channel of the amplifier.



Test:

Run the engine at 90% N_1, do not exceed take-off E.P.R.

Select toggle switch to UP and observe decrease in N_1 R.P.M. (approx. 10%); N_3, N_2, T.G.T. and fuel flow will also decrease proportionally.

NOTE:

It may take 20 secs for the fuel control amplifier to take control.

CAUTION:

Do not select 'CVRD' on the Fuel Control Override Switches whilst the Test switch is in the test position.

Fuel Management

Standard Fuel Loading:

Load tanks 1, 2 and 3 equally.

Standard Fuel Usage:

Feed from tank to respective engine for entire flight. However, it is recommended that fuel quantities in the tanks be equalised prior to landing.

Alternate Fuel Loading:

Load tanks 1, 2 and 3 equally until total fuel reaches 28,570 kgs above 28,570 kgs.
Load only tank 2 until fuel load reaches 38,090 kgs.

Above this point, load tanks 1, 2 and 3 equally until tank 2 is full. Load any remaining fuel equally in tanks 1 and 3.

Alternate Fuel Usage:

1. Feed from tank to respective engine until aircraft gross weight is reduced to 185,480 kgs.
   If take-off weight is 185,480 kgs or less start crossfeed after en route climb is established.

2. After reaching 185,480 kgs crossfeed all engines from No.2. tank until tank quantities are equalised. Tank quantities must be equal by the time total fuel remaining is reduced to 26,310 kgs.

3. When tank quantities are equalised, feed from tank to respective engine.

REFUELLING SYSTEMS

General

The aircraft can be pressure refuelled and defuelled from underwing service points.

There is limited overwing gravity refuelling.

Tank-to-tank transfer of fuel on the ground only.

Pressure Refuelling

General

A pressure refuelling system with two refuelling points (one outboard of each wing engine nacelle) is used to refuel the aircraft. See Power Plant 33 The right side point contains all the gauges and switches necessary to control and monitor the complete refuelling operation. All tanks may be refuelled from one station or the other, or from both sides simultaneously.

Controls are provided so that the quantity of fuel to be loaded into each tank may be pre-set prior to the refuelling operations. The system automatically stops refuelling when the pre-set level is reached.

EXTERNAL REFUELLING AND DEFUELLING PANEL

A picture of the panel is shown on Power Plant 31

SYSTEM POWER SWITCH

ON - Energises pressure refuelling/defuelling system.
Refuelling power ON light at P_3 system station fuel panel is illuminated.
Refuelling/defuelling Valve closed lights illuminated.
Set point test lights are illuminated if pointer is below set bug.
Fuel Quantity indicator repeaters are powered.
Primary and secondary test switch circuit is armed.
Test and defuelling circuits are armed.

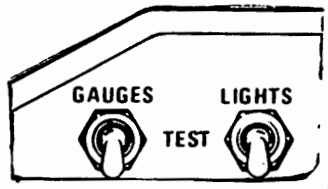
OFF - Entire pressure refuelling/defuelling system is de-energised.

Gauges Test Switch

Normal position - OFF (Sprung to DOWN)

Test position - TEST (Held UP)

Drives all fuel contents gauge pointers towards full and the switch must be held at Test until all guages read full for a complete check of fuel system wiring and instrumentation.



Set point test indicator lights come ON, then go OFF when fuel quantity pointer reaches the set point bug mark.

Releasing switch to OFF allows fuel quantity pointers to return to actual quantity.

Lights Test Switch

Normal position - OFF (Sprung to DOWN)

Test position - TEST (Held UP)

Tests all panel indicator lights, any lights not already ON will come ON.

Isolation Valve Switch

Normal position - CLOSED (DOWN)

Crossfeed refuelling - OPEN (UP)

Opens or closes crossfeed refuelling isolation valve. Isolation valve should be closed when refuelling from two refuelling bowsers to prevent possible transfer of fuel from one bowser to the other.

Isolation Valve Disagreement Light

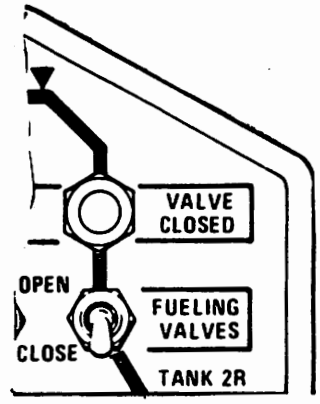
Light is illuminated when isolation valve and isolation valve switch positions are in disagreement.

'Fueling' Valve Control Switch (6)

Normal position - CLOSED (DOWN)

Refuelling position - OPEN (UP)

When placed in the open or closed position supplies electrical power to the fueling valve control relays. Fuel pressure is required to open the valves.



'Fueling' Valve Closed Indicator (6) Light

The light illuminates when the respective fuelling valve is closed.

Fuel Shut off Test Switch

This switch simulates full tanks and tests the float switches and circuitry controlling the fuelling valves.

A three position switch sprung to the centre OFF position.

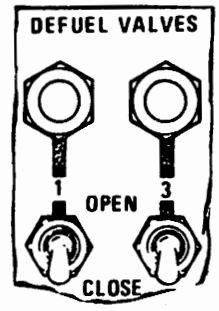
Normal position - OFF

PRI - (Held UP) Tests primary circuits valve closed lights illuminate.

Sec - (Held DOWN) Tests secondary circuits valve closed lights illuminate.

Defuel Valve Switch

Operates in the same manner as the 'Fueling' valve switch.

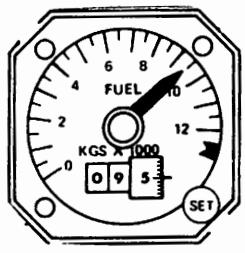


Defuel Valve In-transit Light (4)

The light illuminates when the defuel valve switch disagrees with its valve.

Fuel Quantity Indicators (4)

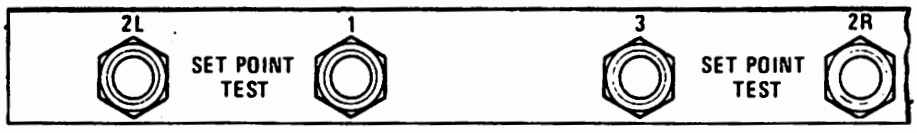
Indicates tank quantity.
Provides pointer and digital readout.
A "Set Bug" to pre-select fuel quantity with automatic shut-off.
When a fuel contents gauge pointer reaches the "Bug" setting the fuel valve will close.
The valve closed light will illuminate.
The set point test light will extinguish.



Set Point Test Lights (4)

Light illuminated - when the selected indicator "set bug" is set above the Fuel Tank Contents Indicator.

Light extinguished - When the Fuel Tank Contents Indicator reaches the "bug" setting.



Pressure Refuelling

For fuel bowser location see Power Plant 33

All tanks may be pressure refuelled from either or both refuelling stations. The refuelling/defuelling control panel is located in the right wing.

Connect static ground wires.

System Power Switch - ON

The six fueling valve closed lights should be illuminated.

Gauges Test Switch - Hold in Test position.

All fuel quantity gauges read full. The set point test lights should come on, then go out when gauge pointer reaches set point bug.

Lights Test Switch - Hold in test position.

Pressure Refuelling (cont.)

Check that all panel indicator lights are not already ON come ON.

Rotate fuel contents indicator set knob so that set bug is positioned to desired quantity.

Connect fuel hoze nozzles and their static ground wires.

Isolation Valve - OPEN.

Fueling Valves - OPEN.

Check the six valve closed lights extinguished. (The fueling valves will not open without fuel pressure)

Fuel Shutoff Test Switch - PRIMARY, then SECONDARY.

Check valve closed lights come on at each positiom then go out when switch is released.

When each tank is filled to desired quantity check:

Valve closed lights are illuminated.

Set point test lights are extinguished.

Quantity gauge pointers are at set bug position.

Isolation Valve - CLOSE

Fueling Valves - CLOSE

System Power - OFF

Close nozzle valves, disconnect hoses, install adapter caps, close access panel cover, drain tank sumps and disconnect static ground wires.

Pressure Defuelling

Ensure fuel bowser suction pressure not more than suction.

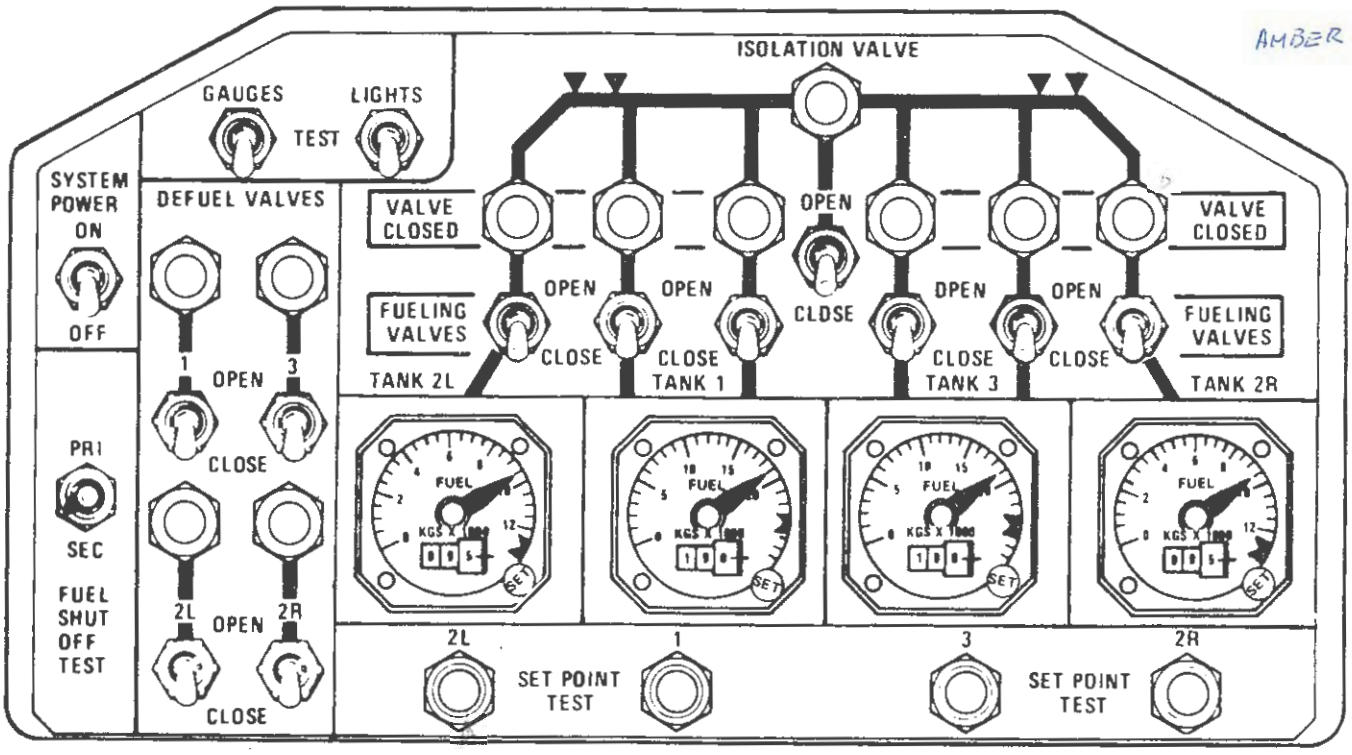
Open tank defuel valves as required.

Set "bug" to the required quantity and defuel.

The isolation valve can be used for wing-to-wing defuelling if only a single fuel bowser is available.

When defuelling the No.2. tank the inboard compartment is defuelled first. When the inboard compartment falls to 450 kgs, the fuel transfer valve will open allowing the outboard fuel to be transferred to the inboard compartment.

REFUEL/DEFUEL PANEL



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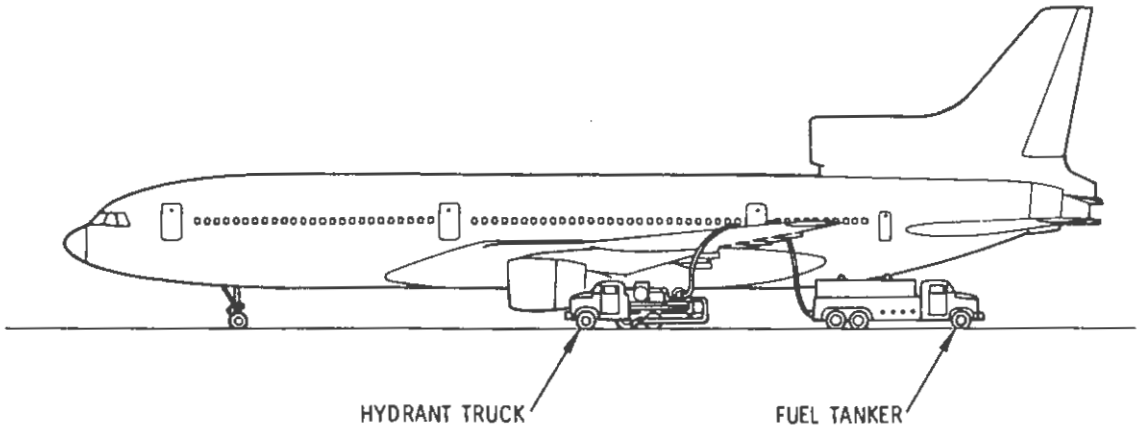
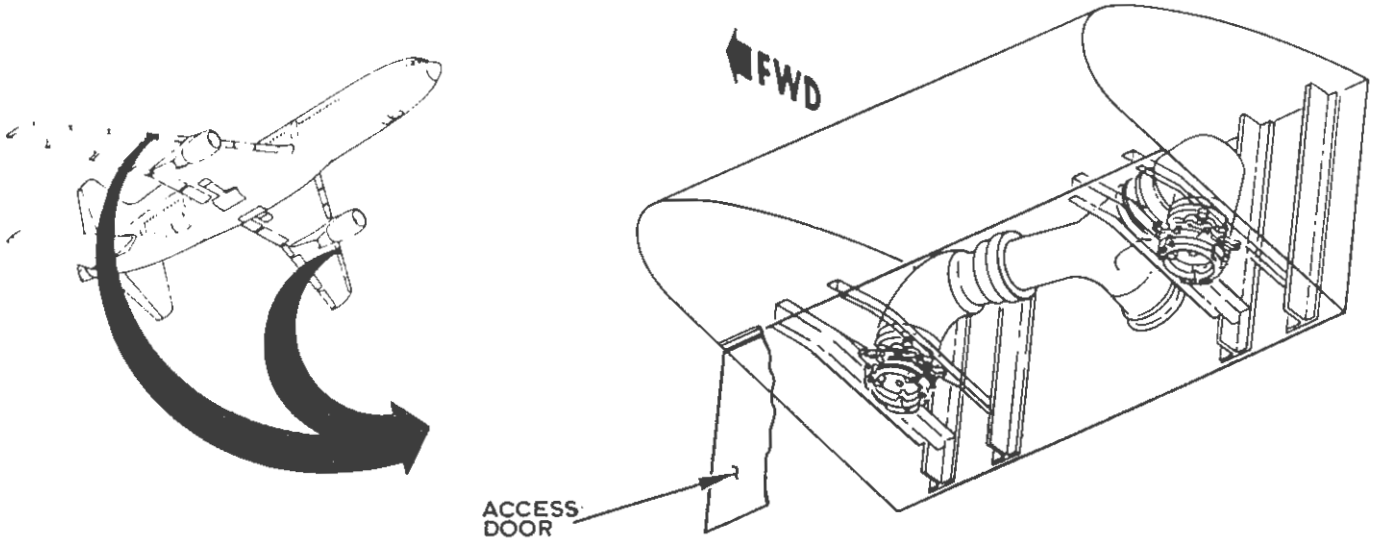
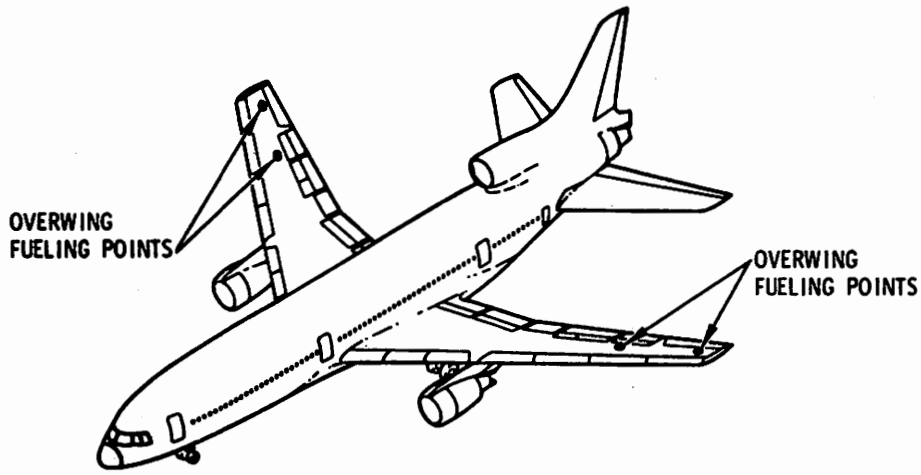
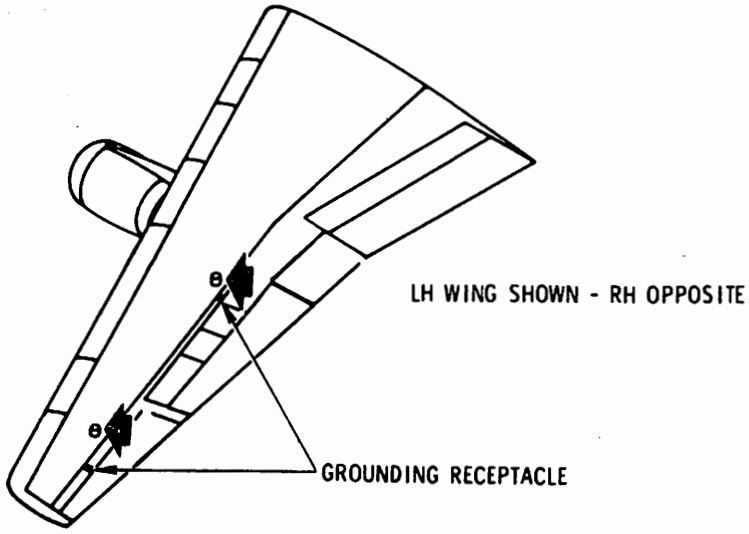
REPLENISHMENT POINTS - PRESSURE REFUELLING

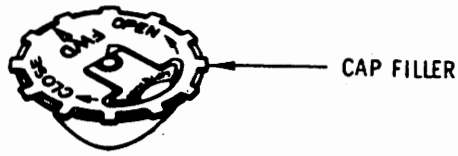


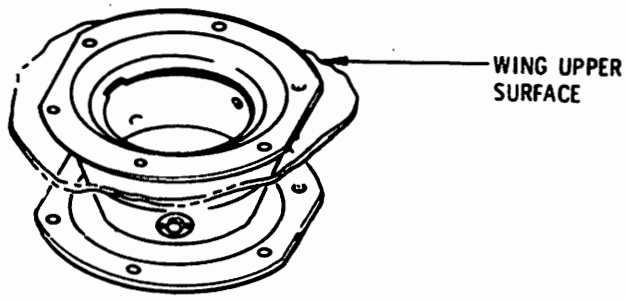


REPLENISHMENT POINTS - OVERWING REFUELLING









Overwing Gravity Refuelling

Overwing filler caps are provided for the outboard and inboard compartments of tanks 2L and 2R only. See Power Plant 34

To manually refuel tanks 1 and 3, fuel can be transferred from the No.2. tanks respectively.

There is no overwing defuelling capability.

Fuel Transfer on the Ground

If it is necessary to transfer fuel from tank to tank (APU or ground electrical power available) use the following procedure. Fuel cannot be transferred in flight.

On Fuel System Panel:

Supply TANK PUMPS Switches (2)	-	ON, Flowbar ON, LOW LIGHT OUT.

On External Refuelling/Defuelling Panel:

SYSTEM POWER Switch	-	ON, VALVE CLOSED LIGHTS (6) ON, SET POINT TEST LIGHTS (4) ON OR OUT (depending on position of contents gauge pointers, and set point bug)
Fuel Contents Indicator Selectors	-	SET TO DESIRED QTY.
ISOLATION VALVE Switch	-	OPEN IF REQUIRED, IN-TRANSIT LIGHT ON AND OUT.
FUELING VALVE (for tank to be supplied)	-	OPEN.
DEFUEL VALVES (for supply tank)	-	OPEN.

When tanks are filled to desired quantity:

FUELING VALVE CLOSED Light	-	ON.
ISOLATION VALVE	-	CLOSE, IF REQUIRED.
FUELING VALVES	-	CLOSE.
DEFUEL VALVE	-	CLOSE
SYSTEM POWER Switch	-	OFF, ALL PANEL LIGHTS OUT.

Fuel Level Sight Gauges

The fuel level sight gauges in the aircraft fuel system are conventional dripless magnetic float sticks. There are six sticks in the lower surface of each wing.

Operation

The sticks are operated:-

To unlock stick, push upward with suitable tool in slot and turn 90° counterclockwise.

Pull stick down until steel insert on top of stick engages with the magnetic ring in the float, then continue to pull down until latching effect of stick and float disengages.

Push stick upward slowly until it relatches with the float.

Read number on stick at bottom wing skin.

To obtain the total quantity in tank 2L or 2R, add the inboard section and outboard section stick readings.

After using sticks they should be relocked by pushing upward into the base and turning 90° clockwise.

The numbers on the sticks represent "inches", to convert inches to Kgs. of fuel, a table or graph is used.

POWER CONTROL

GENERAL

Flat-rating

Flat rating the take-off thrust has become accepted practice with modern civil aircraft powered by turbo jet engines.

Basically this means that for a given ambient pressure (Po), a selected level of thrust is maintained constant across the widest possible temperature range. However, as an extension of this idea the RB211 is also flat rated at all altitudes.

RB211-22B Rating

The RB211-22B is rated at Take-off to 42,000 lb. thrust (nominal) at sea level ISA + 13.9°C. To maintain constant thrust with increasing ambient temperature, the engine fuel control will increase fuel flow. The R.P.M. and T.G.T. will follow. See Power Plant 44

There is a practical limit to maintaining constant thrust this limit will be reached at an ambient temperature of ISA + 13.9°C. Thereafter thrust will decrease.

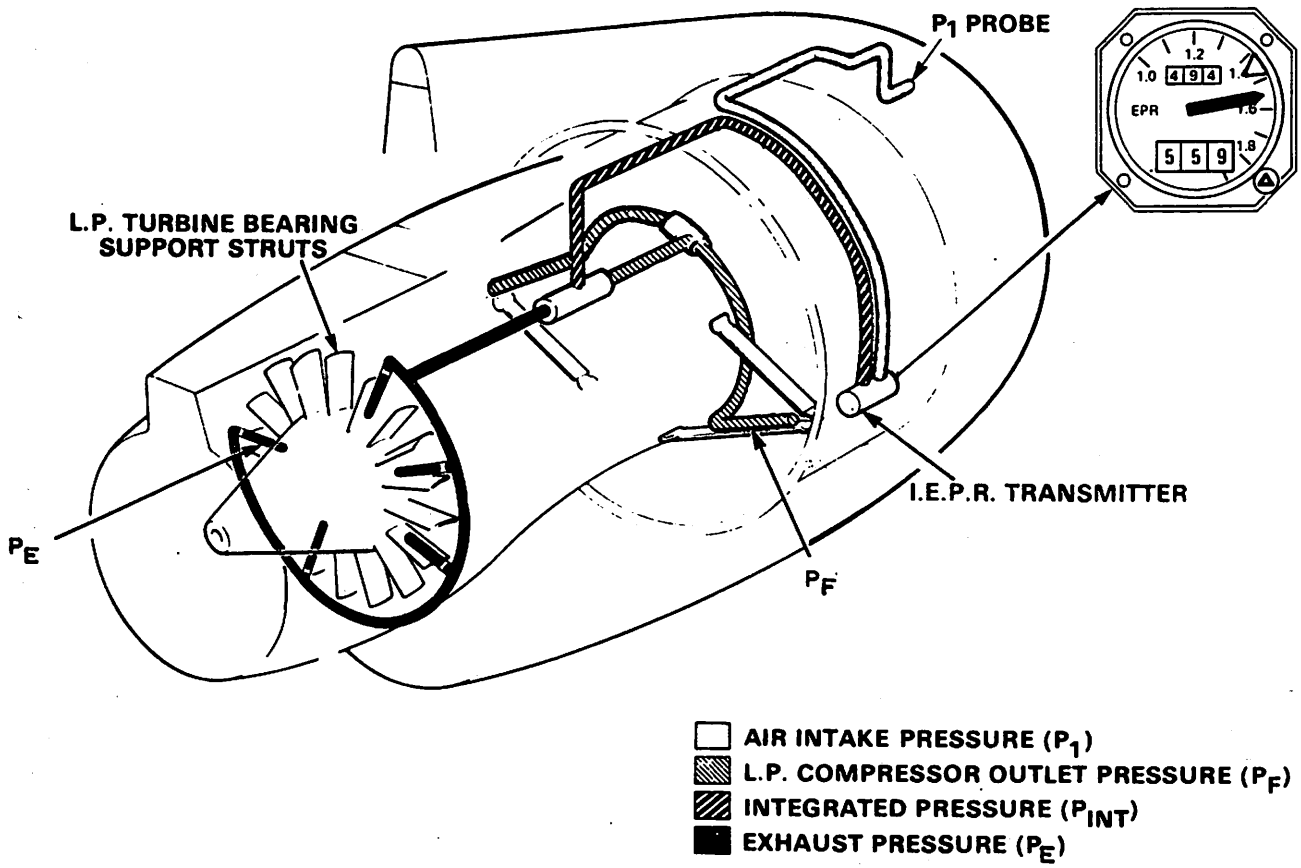
POWER INDICATION

The primary requirement for engine indication and monitoring is a reliable and accurate power check prior to take-off and a straight forward method of setting and monitoring rated performance in flight; which will result in consistent operation both in terms of thrust and engine life.

Engine Pressure Ratio

To meet this requirement on the RB211, power is indicated by Integrated Engine Pressure Ratio (I.E.P.R.) and each engine has an I.E.P.R. gauge. The total power output of a high by-pass turbo fan engine is the sum of the thrust from the fan and the core engine. To measure the total thrust probes are fitted into the fan cold stream outlet and the core engine exhaust. The two signals are added together and compared with the air intake pressure (P_1), the resultant pneumatic signal is transmitted electrically to the I.E.P.R. gauge. Normally, I.E.P.R. is simply referred to as E.P.R. (Engine Pressure Ratio). See Power Plant 38

ENGINE PRESSURE RATIO SYSTEM



E.P.R. Gauges

The engine E.P.R. gauges are located on the pilots centre instrument panel top row of the engine instrument block. For presentation and setting details see Power Plant 3

Engine Control

The throttle lever selects Engine Pressure Ratio (E.P.R.) datums i.e. values of P4/P1. This parameter was chosen because the compressor outlet P4 has a direct relationship to engine thrust. The fuel system will then schedule fuel to meet the selected E.P.R. and produce the required thrust. In practice the throttle lever angle/thrust relationship is almost linear.

E.P.R. Setting

E.P.R. charts are provided to cover various flight conditions e.g. Take-off; sea level; 15°C and no air off-takes the chart E.P.R. value is 1.532.

The E.P.R. gauge bug and set counter are then set to 1.532 and the throttle lever is advanced until the E.P.R. pointer/counter display 1.532. The engine will then be producing the correct power for the stated conditions.

R.P.M.

The R.P.M.s are not selected by the throttle and the three rotating assemblies each have their own R.P.M. range. However, the R.P.M. differential produced will not be constant, varying with throttle lever position and air intake temperatures. Providing the engine produces the selected E.P.R. the engine is delivering the correct thrust. R.P.M.s and T.G.T.s only need to be monitored as being within the engine limitations.

R.P.M. gauges are provided for each section of the engine, N_1 and N_3 are located on the pilots centre instrument panel, N_2 is located at the P_3 systems station panel. For a full description of gauges see Power Plant 3&4

NOTE:
N_1 - 100% = 3,900 R.P.M.
N_2 - 100% = 7,000 R.P.M.
N_3 - 100% = 10,600 R.P.M.

Maximum Limit Devices

Controls are provided in the engine fuel system which will prevent excessive engine R.P.M., turbine gas temperature or thrust. These are:-

1. Low pressure compressor shaft (N_1) speed limiter.
2. Intermediate pressure compressor shaft (N_2) speed limiter.
3. High pressure compressor shaft (N_3) speed limiter.
4. Turbine Gas Temperature (T.G.T.) limiter.
5. Maximum Power limiter.

These limiters all function by controlling engine fuel flow.

Engine Handling

For maximum reliability, engine life and economy in operation, the power taken from a gas turbine engine must be kept to a minimum consistent with the operational requirements. The life of the hot end parts is directly influenced by operating temperature. Special emphasis should be given to the control of the engine during the climb, since a major proportion of the hot end life is used during this phase of flight.

Throttle Lever Handling

The engine is manually controlled by the throttle lever. There are no direct governors controlling R.P.M. and T.G.T. However, max. limit devices are fitted to the engine as described briefly in power control. It must be appreciated that there will be a time lag before they take control of the engine. During this period, the engine normal operating limitations may have been exceeded. Rapid movement of the throttle is permitted but undesirable under normal operation, as this causes high T.G.T. and rapid temperature changes. Full throttle should not be used under normal operating conditions.

Incorrect use of the throttle as detailed above will adversely affect engine life. The engine is reliable and robust but an appreciation of its characteristics will prolong engine life, giving a better aircraft operating economy.

MANAGEMENT

Take-off

For take-off, the engine may be operated at the maximum rating or alternately, to conserve engine life the engine may be operated to a flexible thrust method.

Flexible Thrust

The flexible thrust method based on W.A.T. requirements will give an E.P.R. index to produce the required thrust. This will not be less than the minimum thrust for the actual aircraft weight as certificated in the Flight Manual.

Monitoring

When the specific E.P.R. is obtained, do not re-adjust throttles except to avoid exceeding T.G.T./R.P.M. limitations. The fuel control system will automatically maintain the required thrust although indicated E.P.R. progressively reduces with forward speed, the reduction being significant above 80 kt. At take-off, the indicator will have decreased by approximately 0.01.

If an engine fails to achieve the required E.P.R. within the TGT/RPM limitation, the take-off must not be attempted.

Climb and Cruise

Throttle levers - set to give the appropriate E.P.R. as specified in the climb E.P.R. or cruise E.P.R. charts at the commencement of climb or cruise; accelerate the aircraft to the required speed then monitor E.P.R.s at intervals against the EPR chart values and ensure T.G.T. limitations are not exceeded. There should be no need to adjust the throttles provided there are no large OAT execursions. If held by A.T.C., care should be taken when re-applying power as the engine is manually controlled and there can be a considerable time lag before the maximum limit governors operate.

Monitoring

A close monitoring of T.G.T. in the climb is necessary because on a high by-pass ratio turbo fan engine, more hot end life is used during climb than at any other phase of flight.

In normal cruise flight the power should never exceed the normal climb rating.

Max. Continuous

Max. continuous rating is intended for emergency use only; e.g. following engine power failure. E.P.R. charts are provided for this.

Approach and Landing

Extract the airfield take-off E.P.R. so that in the event of an overshoot the throttle need only be advanced to the specified E.P.R., and monitor R.P.M./T.G.T.

Overshoot

In the event of an overshoot, the throttles should be advanced to give the E.P.R. chart values ensuring that T.G.T. and R.P.M. values are not exceeded.

NO.2. ENGINE FAILURE WARNING SYSTEM

GENERAL

As there is no yaw indication for a No.2. engine power failure, the recognition time is considerably longer than in the case of a wing engine failure.

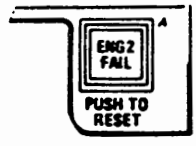
To reduce this recognition time a warning is given to the pilots by two amber lights, one at each end of the glareshield.

INDICATORS

A genuine loss of power will cause the engine to 'run down' when the N_2 (I.P. compressor) R.P.M. falls below 80% the 'ENG 2 FAIL' lights will illuminate.

ENG 2 FAIL Switchlights

A momentary switchlight that is normally extinguished and illuminates the legend ENG 2 FAIL for a No.2. engine failure.



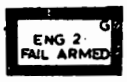
Pressing the switchlight will re-set the system. This is explained in further detail below.

ENG 2 FAIL - ARMED

There are three conditions for arming the warning system:-

1. Flaps selected to a take-off position.
2. Aircraft on the ground.
3. No.2. engine N_2 R.P.M. above 83%.

M.W.S.



The light illuminates to indicate that the No.2. engine failure warning system is armed. The light will be ON during take-off.

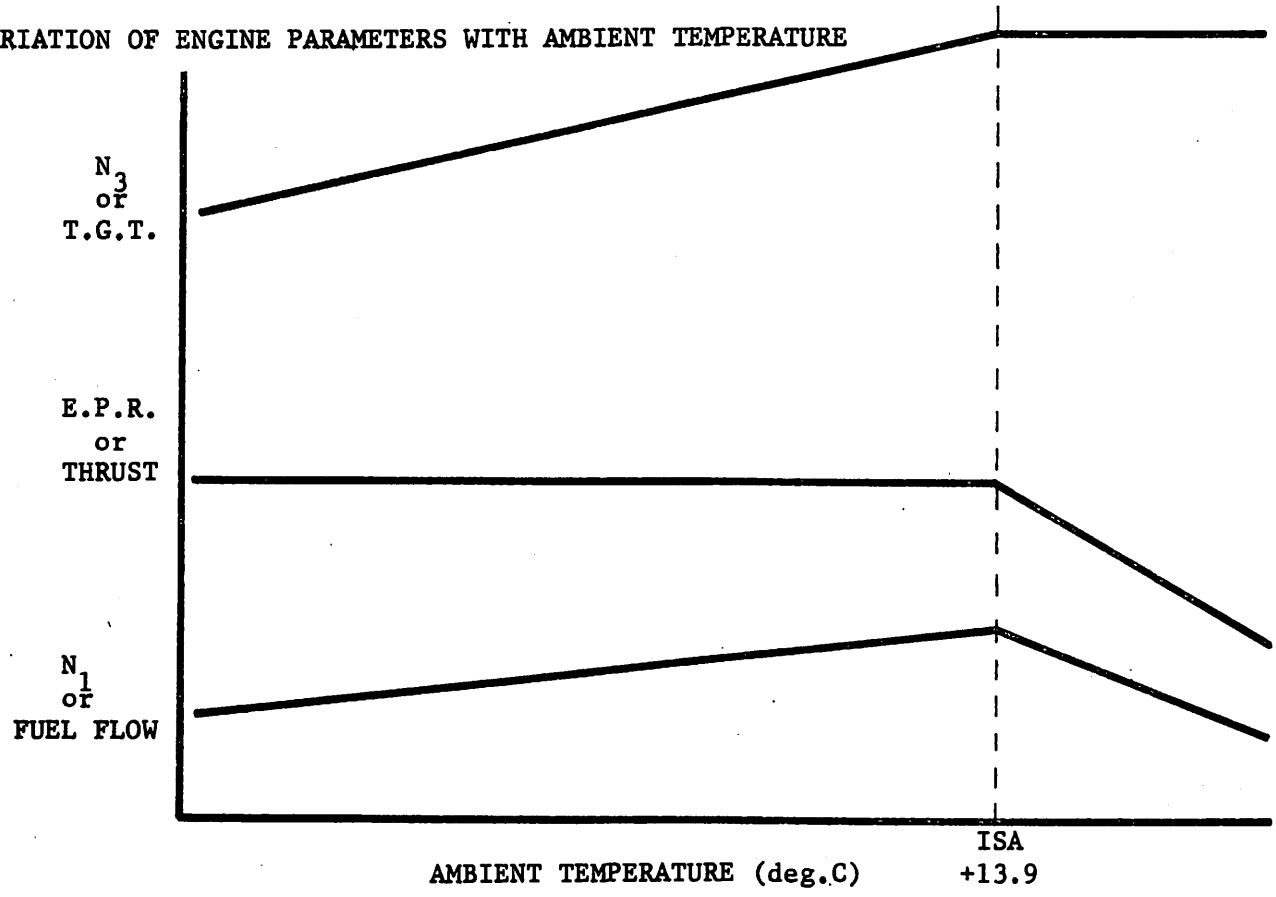
Re-setting

The N_2 R.P.M. signal input to the warning system is taken from an R.P.M. switch within the N_2 R.P.M. indicator on the Engine Status Panel at the P_3 Systems Station. Therefore, reducing R.P.M. by throttle movement or a malfunction of the R.P.M. indicator can illuminate the ENG 2 FAIL lights.

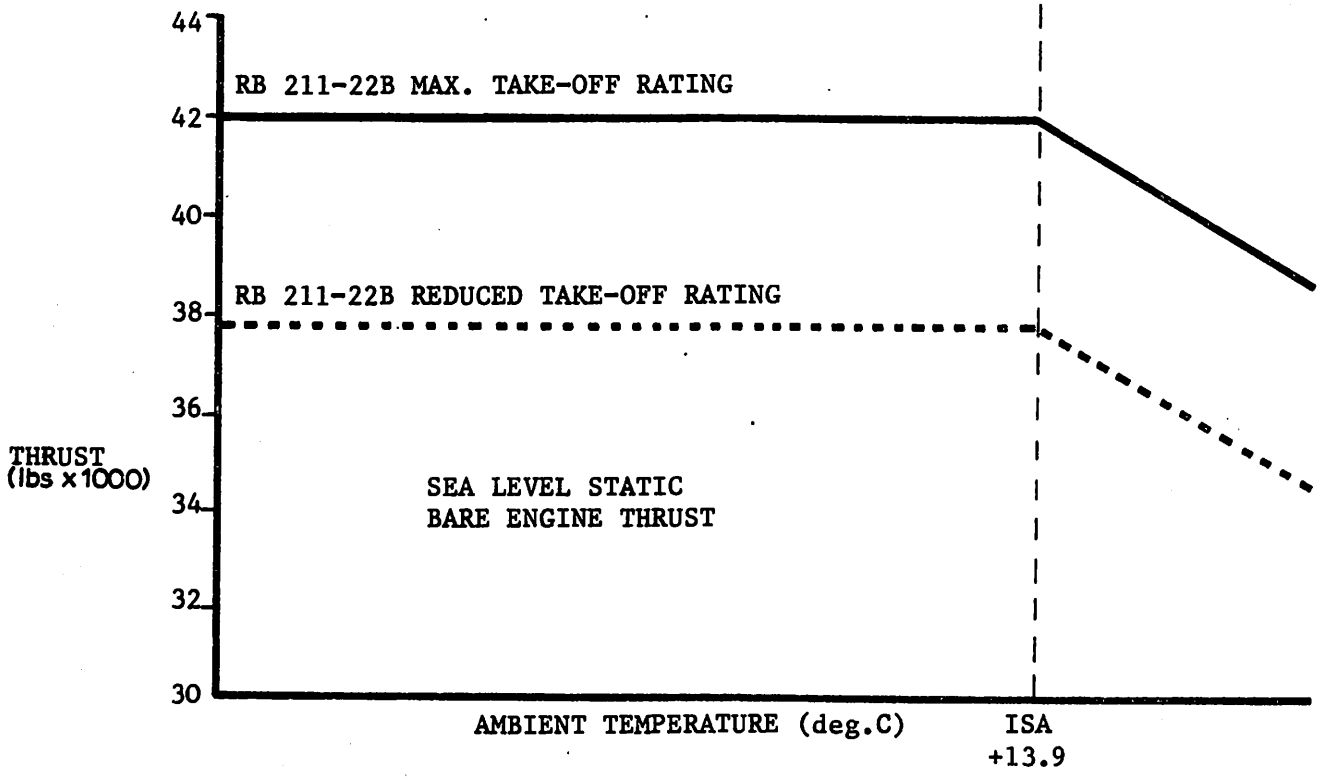
Having identified a false warning, the system can be re-set by either ENG 2 FAIL switchlight, both ENG 2 FAIL and the ENG 2 FAIL-ARMED lights will extinguish.

The system will re-arm when the N_2 R.P.M. increases to 83%, the ENG 2 FAIL-ARMED light will re-illuminate.

VARIATION OF ENGINE PARAMETERS WITH AMBIENT TEMPERATURE



RELATIONSHIP OF REDUCED TAKE-OFF TO MAX. RATING



ENGINE STARTING

GENERAL

Engine rotation for starting is provided by an air starter motor which is fitted to the gearbox and when supplied with high pressure air turns the H.P. section (N_3) of the engine.

Two igniter plugs adjacent to two of the spray nozzles in the annular combustion system 'light up' the engine. Each plug is supplied by its own igniter box and each box is capable of supplying 4 joule low energy power for continuous ignition; or 8 joule high energy power for starting and relighting.

CONTROLS AND INDICATORS

For a full presentation and description refer to Power Plant 47

Air Supplies for Engine Rotation

On the ground:-

1. A.P.U. supplying air.
2. Ground air supply truck.
3. Cross-bleed air supply from a running engine.

In flight:-

1. Windmill start (auto-rotation).
2. Gnd./Assist. Start (APU air or engine cross-bleed).

Normal Starting on the Ground

1.	Start Ignition sw.	- Both.
2.	Gnd. Start sw.	- Press and hold for 5 secs.
3.	Gnd. Start Release	- 'Push' illuminates.
4.	Gnd. Start sw.	- 'Valve Open' illuminates.
5.	N_3 R.P.M.	- Increasing.
6.	20% N_3 Fuel Ignition sw.	- On or Enrich (as required)
7.	T.G.T.	- Rising (Max.550°C. 2 secs.)
8.	45% N_3 Valve Open light	- Extinguishes.
9.	51% N_3 Gnd. Start sw.	- De-latches (audible deck) 'Push' light extinguishes in Gnd. Start Release Sw.
10.	58% N_3	- Engine stabilises at Ground Idle R.P.M.

When cross-bleeding air from No.2. engine set 70% N_3 to produce required duct pressure. Due to characteristics of the air system, any increase in power above 70% N_3 may result in a reduction in duct pressure. After starting the second engine set both running engines to approximately 60% N_3 to produce required duct pressure.

NOTE:

It is permitted but not always necessary to run No. 2 Engine at 70%, where a lower R.P.M. can maintain adequate duct pressure the 'blast' effect of No 2 engine will be reduced.

Before using cross-bleed air from a running engine, check duct pressure is at or above the minimum recommended. However, engine starts may be achieved at slightly lower pressures but such starts may be prologed or N_3 may stagnate.

NOTE:

The following 'rule of thumb' can be applied.

Datum - 27 psi @ 15°C at sea level.
+ 1 psi per 11°C above I.S.A.
- 1 psi per 11°C per I.S.A.
- 1 psi per 1,000 feet above sea level.

To abandon a start sequence for any reason:

Fuel and Ignition Sw. - OFF
Gnd. Start Release Sw. - Push (Hold for 2 secs.)

Fuel and Ignition Switch

'Enrich' may be used to increase the fuel supply for ease of engine starting on a cold day or assist a 'hung engine' (T.G.T. and N_3 are slow to increase) to accelerate. A close watch on T.G.T. will prevent the engine limitations being exceeded. An indication of a hot start will be the T.G.T. rise overtakes the N_3 rise. If this occurs release the switch to the ON position.

Engine Starter Motor

To prevent crash engagement of the starter motor, do not re-engage starter until N_3 R.P.M. is 0% unless an emergency exists.

Starter Motor Cooling

3 Minutes ON
Allow engine to stop (0% N_3)
followed by:

3 Minutes ON
Allow engine to stop (0% N_3)
followed by:

1 Minute ON
30 Minutes OFF
or
5 Minutes ON
30 Minutes OFF.

Abnormal Management

Refer to the Vol 1 Flt. Mang. Engines.

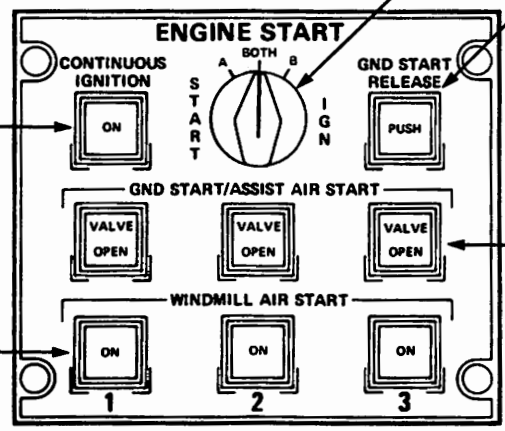
Air Relighting

Normal relighting is achieved by use of the Windmill Air start switch together with the fuel and ignition switch. However, if the I.A.S. at a particular pressure altitude is insufficient then the air starter motor is used to assist the engine to rotate by using the Gnd/Start/Assist Air Start.

To decide on which switch to use, an In-flight Restart Envelope is provided with the Relight Drill.

For the full re-light drill refer to the Emergency Drill.

Engine Starting Controls and Indicators



(Pilot's Overhead Panel)

IGNITION SYSTEM SELECTION SWITCH

Selects:-
A -High energy to one ignition plug
B -High energy to one ignition plug
BOTH -High energy to both ignition plugs

GROUND START RELEASE SWITCH

A momentary push button switch that de-energises the start system.

PUSH illuminated - Engine start valve open.
PUSH extinguished - 51% N_3 when start valve closed or switch is 'pushed' and held in for 2 secs. This action will release the Ground Start switch and cancel engine starting.

CONTINUOUS IGNITION SWITCH

IN - ON is illuminated and both igniter units are armed and with the FUEL AND IGNITION switch at ON both igniter plugs are energised.

OUT - ON is extinguished. Both A and B continuous ignition systems are dis-armed.

GROUND START SWITCH (3)

A momenary solenoid controlled switch which when pressed and held in for 3-5 secs. arms the high energy ignition system and the engine start valve.

VALVE OPEN - Illuminated by the engine start valve opening not by the switch position. Simultaneously the PUSH legend illuminates in the Ground Start Release Switch.

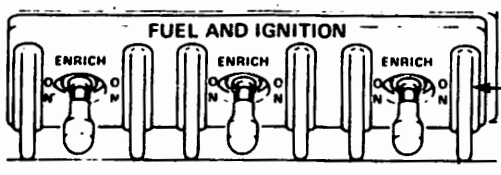
45% N_3 - The VALVE OPEN legend extinguishes as the engine start valve closes.

51% N_3 - The switch de-latches with an audible click and the PUSH legend also extinguishes.

FLIGHT START SWITCH (3)

IN - ON is illuminated and both high energy ignition units are armed and with the FUEL AND IGNITION switch at ON both igniter plugs are energised.

OUT - ON is extinguished and both high energy ignition units are dis-armed.



(Centre Console)

FUEL AND IGNITION SWITCH(3)

ON - Completes all ignition circuits to engine and opens the H.P. Fuel Cock.

OFF - De-energises all ignition circuits to engine and closes the H.P. Fuel Cock.

ENRICH - Spring loaded position that may be used to increase the fuel flow for starting.

INTENTIONALLY BLANK

REVERSE THRUST

GENERAL

All three engines have thrust reversers with minor installation differences on No 2 engine.

Since the fan produces 75% of the total thrust at sea level the required reverse thrust is achieved by reversing the fan cold stream only.

The fan translation cowl is operated by flexible drives powered by an air motor. Control is by combined electrical and mechanical selection, the fan cowl is pneumatic and mechanical in operation.

CONTROLS

Thrust Reverser Levers (3)

Presentation and description of operation together with associated baulks is given on Power Plant 51.

Indicators

Refer to Power Plant 52 for descriptions and presentation, and for abnormal indications and procedures see Vol 1 Flt. Mang. Engines.

NORMAL MANAGEMENT

After landing, to select 'scheduled' reverse thrust, lift the reverse thrust levers up and back and check N_1 and T.G.T. are within the engine limitations. It is recommended that 80% is not exceeded, except where stated in the Vol 3, thus eliminating the necessity of closely monitoring T.G.T.

To avoid ingestion, it is recommended that at a speed of not less than 80 kt., reverse thrust is reduced progressively so that the reverse thrust levers are at the reverse idle position by 70 kt., then cancelled to forward idle at normal taxy speed on engines 1 and 3 ensuring N_1 is less than 33%.

Cancellation to forward idle on No 2 engine may, if desired, be delayed until the aircraft is stopped.

ABNORMAL MANAGEMENT

Under emergency conditions, including abandoned take-off, reverse thrust may be used as required; record and report for maintenance action.

NOTE:

1. After cancelling reverse thrust, the throttle levers must not be advanced in an attempt to increase forward thrust above 33% N_1 until the Reverser Pressure light has gone out.

2. Use of reverse thrust to back the aircraft is not permitted. Reverse idle should only be used on No.2. engine for taxying.

SAFEGUARDS

To safeguard against an in-flight deployment, the system is designed so that a single failure will not cause a hazardous in-flight situation.

System protection is afforded by:-

1. The reverse thrust lever cannot be moved until the throttle is at idle (closed).

2. Whenever the reverse thrust lever is selected into reverse, an electrical and mechanical selection takes place. The electrical selection is routed via aircraft 'weight-on' circuits and should be inoperative in flight; either main u/c leg must be in a 'weight-on' condition to complete the circuit.

This duplication guards against a mis-selection or a spurious system selection during flight.

A further safety feature ensures that should an in-flight deployment occur or any time a reverser attempts to move from the selected position, a reverser driven feedback linkage will move the throttle to the idle position and so reduce engine power to a minimum. This safeguard together with an air motor brake; fan cowl locks; and a sequencing valve protect the system against a 'rogue' air supply attempting to operate the system.

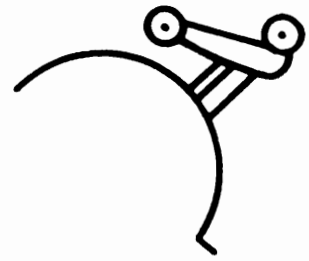
REVERSE THRUST CONTROLS

REVERSE THRUST LEVER (3)

A mechanical baulk prevents the lever moving rearwards until the throttle is at idle.

Initial movement of the lever operates a micro switch via aircraft weight-on proximity switches to select and control sequence of operation.

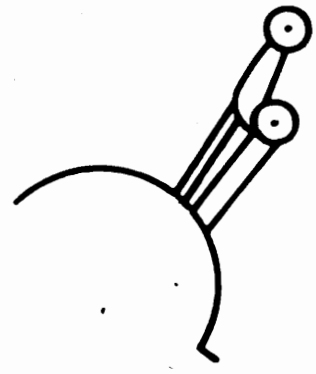
Reverse power is limited to 'Reverse Idle' by a mechanical baulk which is progressively removed as the fan cowl moves beyond mid-travel.



THROTTLE LEVER (3)

In reverse thrust the throttle is locked at Ground Idle.

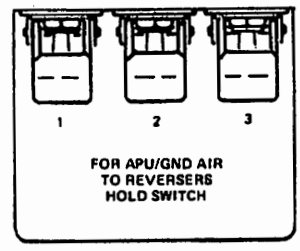
After cancelling reverse thrust the throttle will be prevented from applying forward thrust until the fan cowl completes 25% of its forward travel.



REVERSER TEST SWITCHES (3)

Located at the base of the centre console. Spring-off toggle switches when held in the up position they are ON.

ON - Energises Engine Isolation Valve to reverse flow with air pressure.

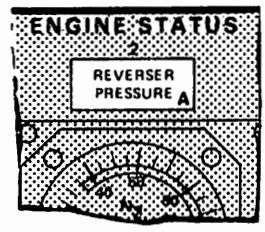


THRUST REVERSER INDICATORS

REVERSER PRESSURE Lights (3)

REVERSER PRESSURE illuminated indicates that the Pressure Regulating and Shut-off Valve (P.R.S.O.V) is open and the HP bleed air pressure is adequate for reverser operations.

REVERSER PRESSURE extinguished indicates insufficient pressure, or P.R.S.O.V. closed.



Systems Station

Reverser UNLOCK Lights (3)

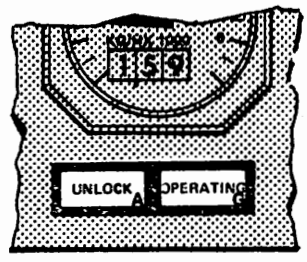
UNLOCK illuminated - Fan translating cowl not locked in Fwd. thrust position.

UNLOCK extinguished - Fan translating cowl stowed and locked in Fwd. thrust position.

Reverser OPERATING Lights (3)

OPERATING illuminated - Fan Cowl fully extended.

OPERATING extinguished - Fan cowl not fully extended.



Centre Inst. Panel

REVERSER INDICATOR LIGHTS SEQUENCE (The indications shown are for a serviceable system).

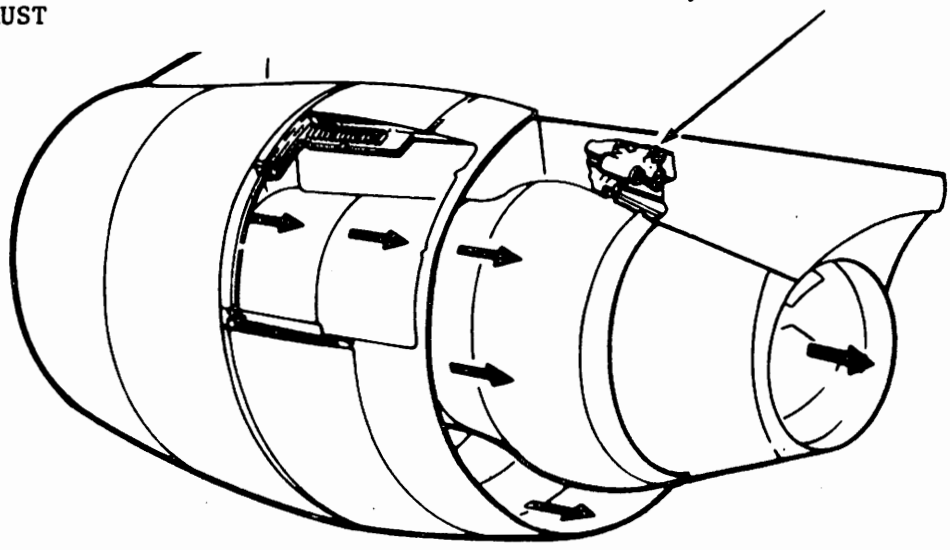
MODE	LIGHTS SEQUENCE			INDICATION
TOUCH DOWN	-	-	-	-
SELECT REVERSE	PRESSURE	UNLOCK	-	FAN COWL UNLOCKED
1 - 1½ SEC.LATER	PRESSURE	UNLOCK	OPERATING	FAN COWL EXTENDED
SELECT FORWARD THRUST	PRESSURE	UNLOCK	-	FAN COWL RETRACTING
1 - 1½ SEC.LATER	PRESSURE	-	-	FAN COWL LOCKED
	-	-	-	P.R.S.O.V. CLOSED

GROUND TESTING

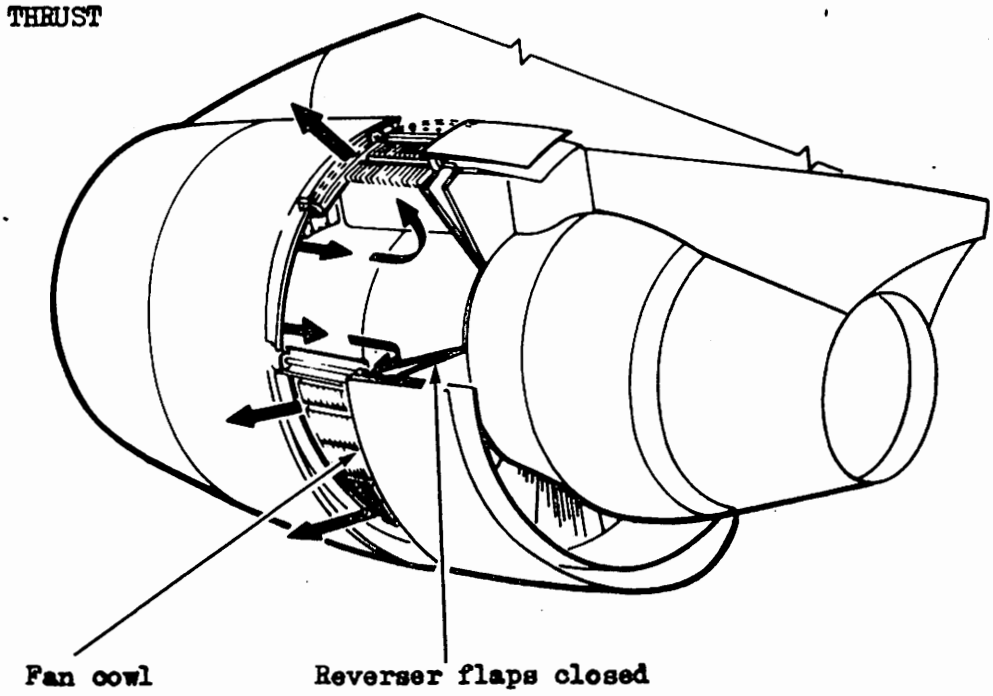
Reverser Test Switches (3)	For presentation see Power Plant 51. These switches are primarily provided for ground engineers to test the reverser operation without the engine running.
To test the Reverser	Latch in the Engine Isolation Valve and High Pressure switchlights. Use engine bleed air from a running engine. Hold toggle test switch to UP.
	Check Engine Isolation Valve and High Pressure switchlight flowbars illuminate.
	Operate the reverse lever and check indicator lights for correct indication.
	Note:
	APU air could be used and the APU would automatically go to Max Mode. However, it is not recommended to use the APU for reverser testing.
	After testing check the Fan Cowl locks and ensure maximum gap at the front edge of the fan cowl does not exceed ½ inch.
CAUTION	Whilst carrying out an external pre-flight inspection of the aircraft, do not put your hands near any part of the reverse thrust mechanism. It is a heavy piece of hardware that moves full travel in 2-3 secs. The system can be operated on the ground without an engine running as detailed in Ground Testing.

THRUST REVERSER - MECHANICAL ARRANGEMENT

NORMAL THRUST



REVERSE THRUST



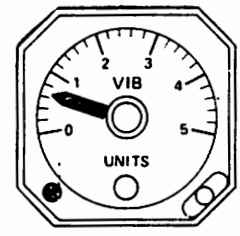
ENGINE VIBRATION

GENERAL

The engine has three main rotating assemblies referred to as the L.P. (Low Pressure) shaft; I.P. (Intermediate Pressure) shaft; and the H.P. (High Pressure) shaft. Each shaft has its own R.P.M. range and the relative speeds of each vary with flight conditions and Engine Pressure Ratio (E.P.R.) so that, the frequency and amplitude of each shaft is different. This fact is used to determine which shaft is the cause of vibration. By fitting a 'pick-up' to the front end of the engine and to the rear end not only is the average engine vibration level detected but which end of a shaft is at fault.

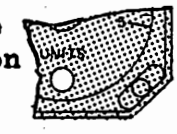
ENGINE VIBRATION INDICATORS

Located on the Engine Status panel at the P3 Systems Station. Indicates a continuous reading of the vibration level as selected by pick-up selector and engine shaft vibration selector.



ENGINE VIBRATION CAUTION LIGHTS

An amber light, located at the bottom of the instrument, illuminates when engine vibration level exceeds 2.5 units.



M.W.S.

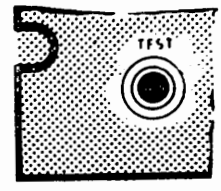
Vibration level above 2.5 units
or
Operating System Test Switch.

Testing (B.I.T.E.)

Momentary pushbutton switch which drives the pointer to read 4.0 units. The amber warning light will also illuminate, but it does not bring up the M.W.S.

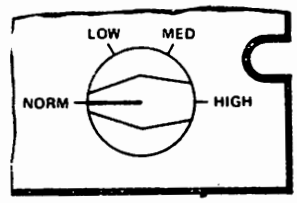
TEST SWITCH

Momentary pushbutton switch which tests the system and the indicators. The pointers read 4.0 units, the amber lights illuminate, and the M.W.S. is operated.



ENGINE SHAFT VIBRATION SELECTOR

Located on the Engine Status Panel at the P3 Systems Station.



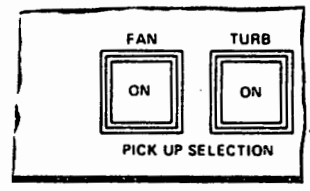
Four position rotary switch:-

NORM.	Selects vibration level of all engine shafts.
LOW	Selects vibration level of L.P. engine shafts.
MED.	Selects vibration level of I.P. engine shafts.
HIGH	Selects vibration level of H.P. engine shafts.

VIBRATION PICK-UP SELECTOR SWITCHES

Located on the Engine Status panel at the P3's System Station.

Switch lights which provide vibration pick-up selection.



Fan - selects engine front end pick-up signal.

Turb - selects engine rear end pick-up signal.

Normal position - both switches latched out.

OUT - ON extinguished.
Both pick-ups (Fan and Turbine) will be monitoring alternatively.

IN - ON illuminated Fan or Turbine pick-up monitoring as selected.

NORMAL MANAGEMENT

Pre-Take-off

Engine Shaft Vibration Selector	- Normal.
Fan and Turb Vibration Pick-up Selector Switches	- De-latched. ON lights extinguished.
Engine Vibration Caution Lights	- Extinguished.
Engine Vibration Indicators	- Pointers reading within limits. (approx. 1 unit)

In-Flight

Most engines when operating normally have indicated vibration levels between 0.4 and 0.8 units in the Normal band at cruise or higher power settings. Any significant increase in reading (1.0 units or more) with or without the amber warning lamp should be investigated. The amber warning lamp is set to illuminate at 2.5 units.

ABNORMAL MANAGEMENT

To investigate an increased level of vibration latch in the fan switchlight and the 'ON' legend will illuminate, rotate the Engine Shaft Vibration Selector through Low-Med-High and record the readings; repeat the procedure with only the Turb switch light latched in.

For appropriate action see Volume 1, Flt. Mange Engines.

NOTES:

1. The Engine Shaft Vibration Selector should be left at Normal in flight in order to detect the average vibration level of all three shafts.

2. The Fan and Turb switchlights must be de-latched and their 'ON' legends extinguished. If both were selected ON, an inaccurate summation of the signals would occur, although a high level of vibration could still be detected but the system was not designed to be used in this mode.

ENVIRONMENTAL CONTROL SYSTEM

CONTENTS

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Engine Bleed Air	1 - 9
Air Cooling System	10 - 14
Cabin Temperature Control	15 - 18
Underfloor Conditioning	19 - 22
Pressurisation	23 - 28
Schematic Diagrams	29 - 31
Summary of Abnormal Indications	**32 - 33**

ENVIRONMENTAL CONTROL SYSTEM

INTRODUCTION

Air conditioning is provided by tapping the compressors of each engine and delivering this air via a cross bleed system to three separate conditioning packs for temperature control. (The APU and ground air supplies are also delivered to the cross bleed system). Each pack passes the air to a common chamber from which delivery is made to the flight deck, forward, mid and aft cabin, and the galley.

The temperature control packs combine to adjust the delivery temperature to suit the lowest required of the five areas - usually the flight deck or the galley.

The delivery temperature for the other areas is raised by adding hot air through individual area mixing valves.

Normally, the system is fully automatic but manual control is available if required.

System abnormality is indicated by an extensive overheat warning system and a monitoring system gives temperature and flow indications throughout the entire system.

ENGINE BLEED AIR

SYSTEM DESCRIPTION

Air supplies are provided by tapping the intermediate compressor of each engine and regulating the delivery of this air by an ejector unit. When the IP compressor outlet pressure is low, or while anticing is in use, delivery is automatically supported by tapping air from the HP compressor and mixing this with the IP air in the ejector. If required, HP air delivery to the ejector can be shut off by a flight deck selection.

The regulated air from each engine passes via isolation valves to a cross bleed duct, and from the cross bleed duct delivery is made to the three air conditioning packs.

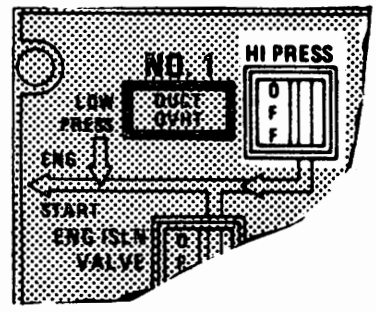
The APU air output is connected into the No.2. engine delivery ducting and three ground air connections are fitted into the cross bleed ducting.

Air supplies for starting, anticing and ATM operation are made between the engine and cross bleed ducting.

Two connections for ground conditioned air are provided in the distribution ducting.

CONTROLS AND
INDICATORS

HIGH PRESSURE
VALVE SWITCH (3)



Normal Position — Latched IN.

Normal Indication — Extinguished.

Purpose — The high pressure valve will shut off the delivery of HP compressor air to the ejector.

Latched IN — While the IP compressor output is adequate the high pressure valve remains shut and the flowbar and OFF are extinguished.

When the delivery pressure falls, the high pressure valve opens to supplement the airflow. As the valve opens the white flowbar illuminates.

As the IP compressor output increases the valve shuts and the flowbar extinguishes.

When wing anticing is selected, the HP valve may open to maintain an adequate temperature for anticing.

Similarly, when the C2 Air Turbine Motor hydraulic pump is running, the HP valve may open to maintain an adequate airflow.

Latched OUT — The valve is locked shut and OFF is illuminated to indicate the switch position.

Abnormal Operation — The valve will automatically close following:-

(i) Nacelle/Pylon overheat

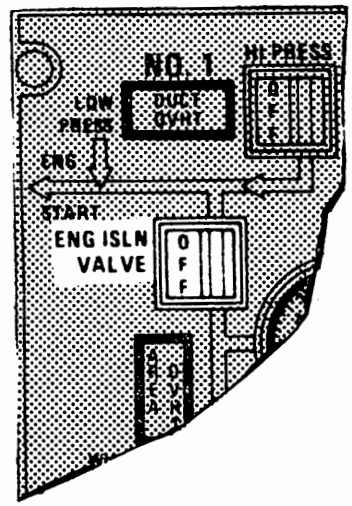
(ii) Duct Overtemperature.

When automatically closed, the OFF does NOT illuminate because the switch remains latched IN.

To re-open the valve, the switch must be re-cycled OFF then ON.

Power Failure — The valve is energised CLOSED, therefore a power failure will not affect valve opening but the flowbar will remain extinguished.

ENGINE ISOLATION VALVE SWITCH (3)



Normal Position — Latched IN.

Normal Indication — Flowbar illuminated.

Purpose — The isolation valve controls the delivery pressure to approximately 45 p.s.i. It will also isolate the ejector and engine from the cross bleed duct.

Latched IN — With no airflow the valve is closed and the flowbar is extinguished.

As the airflow builds up, the valve will open and the flowbar illuminates.

A reverse flow through the isolation valve is permitted during engine starting and ground servicing. (The flowbar will illuminate during a reverse flow).

Latched OUT — The isolation valve is locked shut and OFF is illuminated to indicate switch position.

Abnormal Operation — This is similar to the High Pressure Valve.

The valve will automatically close following:-

(i) Duct over-pressure.

(ii) Duct over-temperature.

(iii) No.1. and 3 engine duct excessive flow.

(iv) Pulling the engine fire control handle.

(The OFF legend does not illuminate because the switch remains latched in).

The switch must be cycled OFF-ON to re-open the valve, except when closed by the fire control handle.

Power Failure — The valve is energised closed, therefore a power failure will not affect valve opening but the flowbar will remain extinguished.

OVERPRESSURE VALVE

There is no flight deck control of this valve.

P_3 Annunciator Panel warning.

Purpose

It protects the ducting against excessive pressure if the engine isolation valve regulation fails.

Operation

As the valve operates, signals are sent to:-

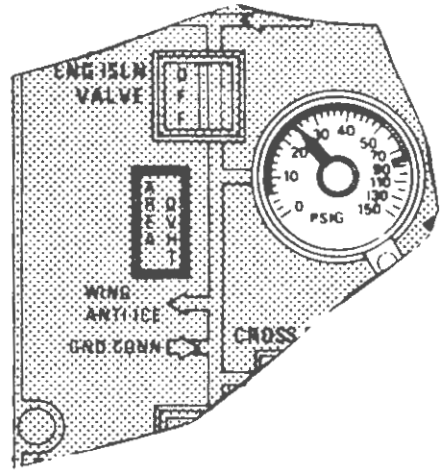
(i) Illuminate the overpressure warning.
(ii) Shut the engine isolation valve.

When the isolation valve locks shut, the pressure will reduce but the warning is locked in until the isolation valve switch is latched out.

DUCT PRESSURE INDICATOR (3)

Normal Indication

40–45 psi (in flight)



FUSELAGE ISOLATION VALVE SWITCH (NO.2. ENGINE ONLY)

Normal Position

Latched IN.

Normal Indication

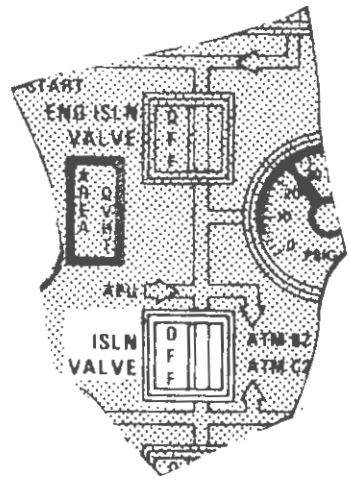
Flowbar illuminated.

Purpose

It allows the use of one ATM following the failure of No.2., or the cross-bleed, ducting.

Latched IN

This is the same as a cross-bleed valve.

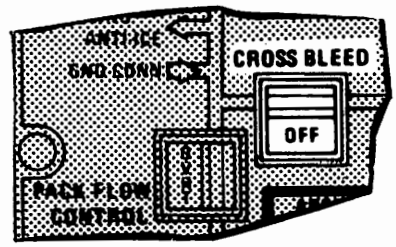


As the valve is opened by airflow, the flowbar is illuminated.

A reverse flow occurs during starting.

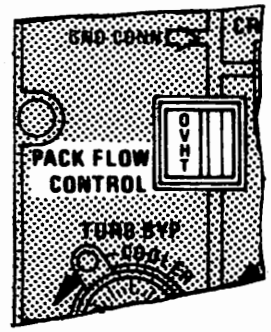
Latched OUT	The valve is locked shut and OFF is illuminated.
Abnormal Operation	This valve, with others, automatically locks closed following an excessive flow, the flowbars extinguishing. All associated switches must be latched out together to break the lockout circuit. (See Excess Flow Lock-out)
Power Failure	The valve is electrically energised to open. Power failure will therefore lock the valve shut, OFF remaining extinguished.

CROSSBLEED VALVE SWITCHES (2)



Normal Operation	
Normal Indication	
Purpose	Allows cross bleeding from any air supply to any conditioning packs.
Latched IN	The valve will open if pressure exists on either side of the valve. As the valve opens the flowbar will illuminate.
Latched OUT	The valve is locked closed and OFF is illuminated.
Power Failure	The valve is electrically energised to open, a power failure locks the valve shut.

PACK FLOW CONTROL SWITCHES (3)



Associated MWS	With OVHT illuminated. ECS
Normal Position	Latched IN.
Normal Indication	OVHT extinguished. Flowbar illuminated.
Purpose	Temperature control pack shut-off valve and flow regulator.
Latched IN	The valve maintains the mass flow constant by progressive movement. With the valve open the flowbar is illuminated.
No.2. only	If C 2. ATM is running and the duct pressure falls below 12 p.s.i., No.2. flow control valve shuts to maintain adequate air supply for the ATM. (The flowbar extinguishes as the valve shuts)
Latched OUT	The valve locks shut and the flowbar is extinguished.
Abnormal Operation	The valve will lock shut following:- (i) Low delivery pressure. (No 2 only) (ii) OVHT illumination. (iii) Excessive flow. The OVHT warning is introduced by defects in the air conditioning system. The switch must be cycled OFF-ON to re-open the valve.
Power Failure	Loss of electrics will not prevent the valve opening but automatic temperature control is dependent upon power to the valve controller. Therefore, these facilities will not be available.

SYSTEM ABNORMALITIES

EXCESS FLOW LOCKOUT

If an excess airflow is detected the following valves are automatically locked shut.

No.1. system - No.1. Flow Control Valve.
No.1. Engine Isolation Valve.
Left Cross Bleed Valve.

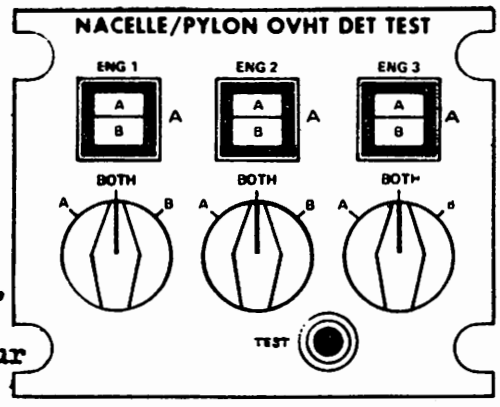
No.2. system - No.2. Flow Control Valve.
Fuselage Isolation Valve.
Left Cross Bleed Valve.
Right Cross Bleed Valve.

No.3. system - No.3. Flow Control Valve.
No.3. Engine Isolation Valve.
Right Cross Bleed Valve.

The lockout can only be broken by unlatching all associated switches simultaneously.

NACELLE/PYLON OVERHEAT

Associated MWS



Operation

If an engine nacelle or pylon air delivery duct fails, any overheat will be detected by the sensors.

(An overheat will only occur if the H.P. valve is open)

If both loops detect an overheat:-

1. The appropriate MWS NACELLE OVHT is illuminated.

2. Both loop lamps are illuminated.

3. The HI PRESS valve will automatically lock shut.

A single loop detection with that one selected has the same effect as a double loop detection.

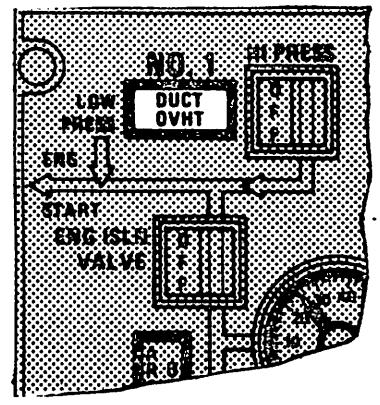
A single loop detection with BOTH selected will illuminate the appropriate loop lamp and close the HI PRESS valve but <u>not</u> introduce the MWS.

Handling

Flight Management. Section Page

DUCT OVERHEAT

Associated MWS



Operation

A two stage sensor is fitted between the ejector and engine isolation valve.

Stage 1. No MWS or duct overheat warning is illuminated.

The high pressure valve cycles to maintain the temperature within Stage 1 limits.

The flowbar illumination cycles with valve movement.

Stage 2. The MWS and duct overheat warnings are illuminated.

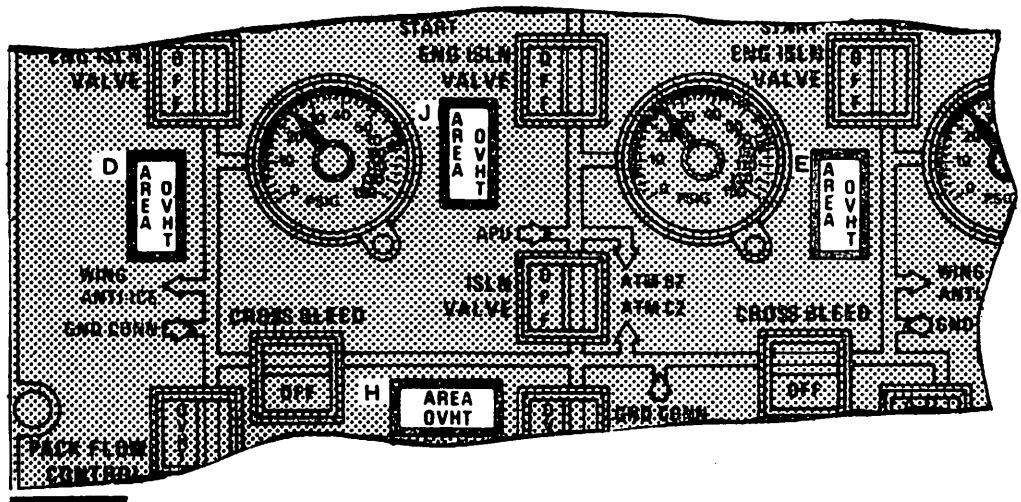
The high pressure valve and engine isolation valves are locked shut. The flowbars are extinguished.

Handling

Flight Management. Section Page

AREA OVERHEAT WARNINGS.

Areas D, J, E, and H.



Associated MWS

Purpose

Indicates an overheat of the following area:-

D and E	Between the engine isolation valve and pack flow control valve.
J	Between the engine isolation valve and fuselage isolation valve.
H	Between the fuselage isolation valve and the crossbleed valves.

Operation

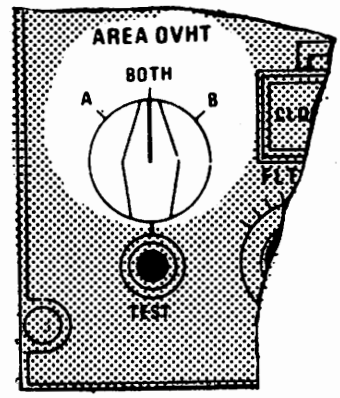
The detecting system consists of a dual loop surrounding the ducting. A signal from either loop will illuminate the warnings.

There is no automatic action and the overheat must be controlled by selecting the appropriate valves shut.

LOOP SELECTOR

Purpose

Selects the loop that will illuminate the overheat warnings.

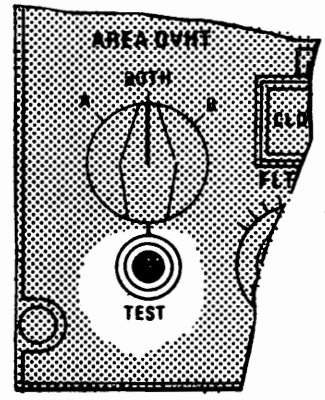


TEST BUTTON

Operation

Tests the <u>selected</u> detector loop.

When pressed, all associated area overheat lamps and MWS display should illuminate.



ENVIRONMENTAL CONTROL SYSTEM

AIR COOLING SYSTEM

SYSTEM DESCRIPTION

The cooling system consists of a conventional turbo-compressor cold air unit (Air Cycle Machine A.C.M.) and a two stage heat exchanger.

From the pack flow control valve the air passes through the first stage heat exchanger. A percentage of this air then passes directly through the second stage heat exchanger while the remainder is compressed, passed through the heat exchanger then further cooled by the turbine. The ratio of air directed through the cold air unit is controlled by the position of the Turbine Bypass Valve (T.B.V.)

Heat exchanger cooling efficiency is adjusted by controlling the position of the ram air louvres.

Normally in flight, louvre opening is automatically restricted to 30% open to reduce airflow noise.

Normally on the ground, the louvres move fully open to ensure adequate cooling.

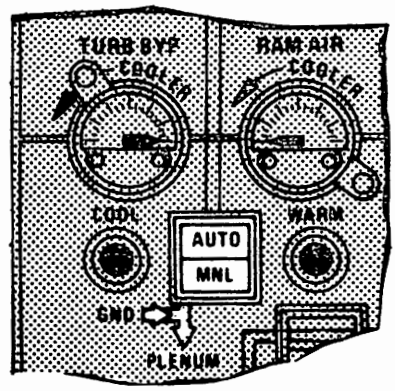
The louvres and bypass valve are related to each other so that one will move to its extreme position before the other begins to move.

A fan is connected to the cold air unit to assist in heat exchanger cooling when ram air is inadequate.

Control of the louvre and bypass valve position is normally automatic but direct control is always available. When controlled by the direct control switches, automatic anticing of the water extractor, and the ram air louvre restricted opening of 30°, is removed.

CONTROLS AND INDICATORS

TEMPERATURE AUTO/ MANUAL SWITCHES (3)



AUTO Operation

Latched IN.
AUTO illuminated.

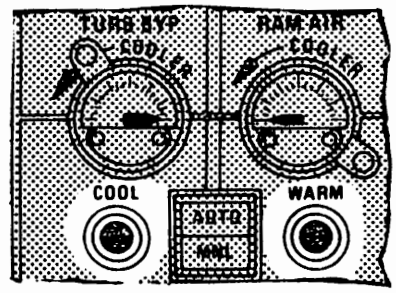
The ram air louvres and the bypass valve are automatically controlled to achieve and maintain the required delivery temperature.

MANUAL Operation

Latched OUT.
MNL illuminated.

The COOL and WARM switches are armed. The louvres and bypass valve will only move as a result of COOL or WARM switch selections.

COOL AND WARM SWITCHES (3 of each)

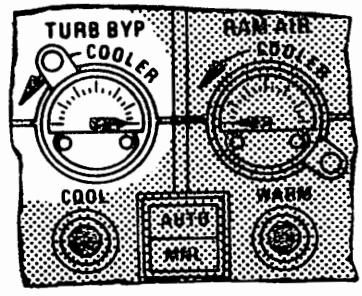


Operation

COOL - Armed with MNL selected. While pressed, the ram air louvres move to the full cool position then the TBV moves to cool position.

WARM - Armed with MNL selected. While pressed, the bypass valve moves to the full warm position then the louvres begin to close.

TURBINE BYPASS VALVE INDICATOR (3)

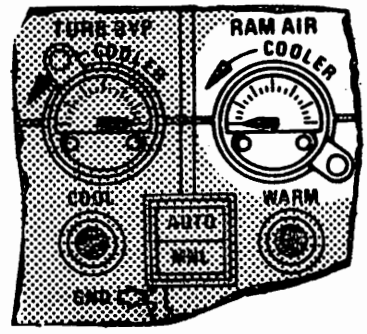


Operation

The pointer moves in the COOLER direction as the valve closes.

Valve movement towards COOLER will begin when the ram air louvres are in their maximum cool position.

RAM AIR LOUVRE INDICATOR (3)



Operation

The pointer moves in the COOLER direction as the louvres open.

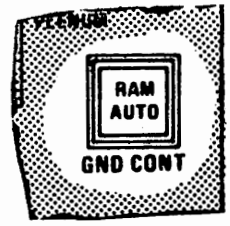
In flight, with AUTO selected, louvre opening is restricted to a maximum of 30% open.

On the ground, with AUTO selected, the louvres will automatically fully open.

Louvre movement away from COOLER will begin when the bypass valve is in the fully warm position.

When controlling manually, there is no automatic restriction of louvre movement.

GROUND CONTROL SWITCH



Associated MWS

With RAM AUTO illuminated.

Flight Position

Latched IN.

Indication

Extinguished.

Latched IN

In flight, the ram air louvre operation is normal.

On the ground, providing the AUTO/MNL switch is selected to AUTO, the louvres are moved to the full cool position, reducing the possibility of a system overheat.

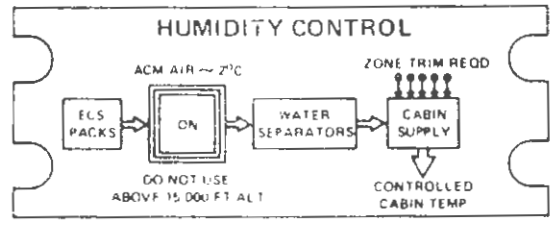
Latched OUT

RAM AUTO and MWS illuminated.

The louvres are free to move within the flight range to any position required by the temperature controller. (This gives a quicker warm up to the aircraft).

HUMIDITY CONTROL SWITCH

This panel is located on the main systems panel, and consists of a schematic layout and single switch.



Purpose

In warm and humid conditions some water vapour remains in the cabin air and this can lead to fogging and condensation in the ducting.

The efficiency of the water separator is improved by lowering the temperature of the air.

This is done by the humidity control switch.

Normal Position

Latched OUT.

Normal Indication

Extinguished.

Latched OUT

The switch is non-effective and the temperature control responds to normal inputs.

Latched IN

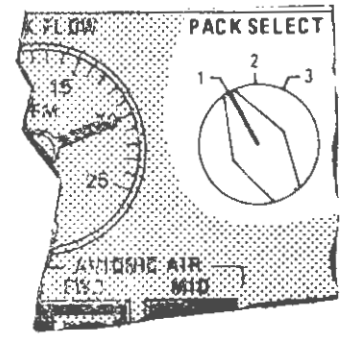
The ON lamp is illuminated.

The temperature controller controls the ACM discharge temperature to +2°C.

COOLING SYSTEM MONITORING

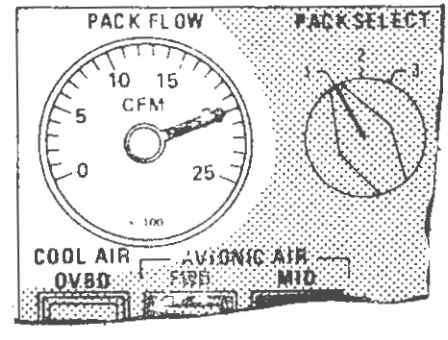
PACK SELECTOR

Selects the pack for flow and temperature indication.



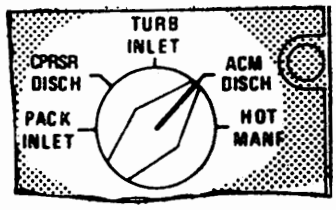
PACK FLOW INDICATOR

Indicates the outlet rate from the selected pack. No.1 is normally slightly higher than 2 and 3.



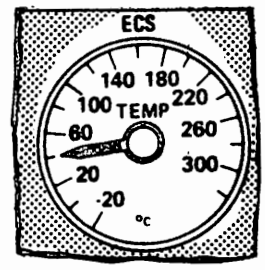
TEMPERATURE SELECTOR

Selects the location of the indicated temperature.



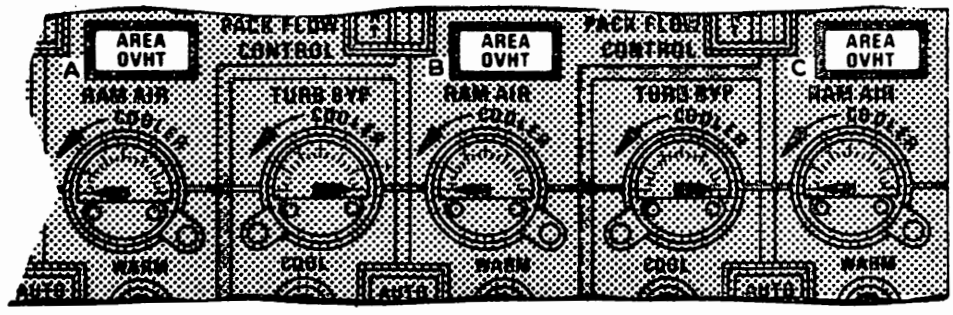
TEMPERATURE INDICATOR

Indicates the air temperature of the selected location.



AREA OVERHEAT WARNINGS

AREAS A, B AND C.



Associated MWS

Purpose

The warning indicates an overheat in the area between the pack flow control valve and the primary heat exchanger inlet.

Operation

The operation is identical to areas D, E, J. H.

There is no automatic action, the overheat must be controlled by shutting the appropriate pack control valve.

As the area temperature decreases the warning extinguishes.

A duct failure in the forward cargo heater heat exchanger will cause all three area overheat lamps to illuminate simultaneously.

Elsewhere in the system, a single overheat warning will inhibit the other two warnings while the pack flow control switch is latched IN.

LOOP SELECTION AND TESTING

As described in Areas D, E. J. H.

CABIN TEMPERATURE CONTROL

SYSTEM DESCRIPTION

The cool air from the three packs is delivered to a plenum (manifold) from which the air is ducted to five fuselage zones.

The temperature control systems combine to deliver air at the lowest temperature required by the five zones - this is usually the flight deck, galley, or aft cabin. The delivery temperature to the other zones is increased by the addition of hot air.

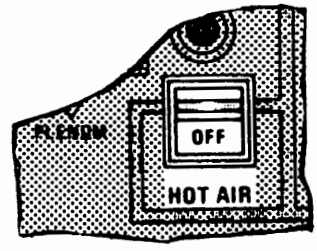
The hot air is derived from Nos. 2 and 3 packs. Delivery from either pack can be shut off by an isolation valve.

Hot air is tapped from the pack outlet and warm air is tapped from the first stage cooled air. A hot air valve mixes air from both sources to maintain the temperature of the hot air constant.

The zone temperature is achieved by trim valves that control the amount of hot air added to the cool air.

CONTROLS AND INDICATORS

HOT AIR VALVE SWITCH (Nos. 2 & 3 Systems)



Normal Position — Latched IN

Normal Indication — Flowbar ILLUMINATED.
OFF extinguished.

Purpose — The valve mixes the hot air and warm air to maintain a hot air manifold temperature at 100 to 130°C.

Latched IN — The flowbar illuminates as the valve opens.

If the associated pack flow control valve is shut, either by selection or automatically, the hot air valve will lock shut and the flowbar will extinguish. To re-open the valve the pack valve must be opened and the hot valve switch cycled OFF/ON.

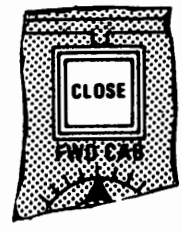
Latched OUT — The valve will lock shut, the flowbar will extinguish and OFF is illuminated.

Power Failure — Valve opening is not affected but the flowbar will be extinguished.

ISOLATION VALVE SWITCH
(Nos. 2 & 3 Systems)

Associated MWS	With OVHT illuminated. ECS
Normal Position	Latched IN
Normal Indication	Flowbar illuminated. OVHT extinguished.
Purpose	It permits the shutting off of the appropriate air supply to the hot air manifold.
Latched IN	The operation is similar to the Hot Air Valve. As the valve opens the flowbar is illuminated. Shutting the pack flow valve will also shut the isolation valve, cycling of the switch being necessary to re-open the valve.
Latched OUT	The valve locks shut and the flowbar is extinguished.
Abnormality	If either of the hot air ducts fail, it would cause an overheat of the forward electronic service centre. Operation of the FESC sensor will illuminate the MWS and both OVHT lamps and also lock both isolation valves and hot air valves shut (the flow bars will extinguish). As the FESC cools, the OVHT lamp will extinguish
Power Failure	The valve will lock closed.

ZONE TRIM VALVE
SWITCH (5)



Normal Position	Latched IN.
Normal Indication	Extinguished.
Purpose	The trim valves add the necessary amount of hot air to achieve the selected zone temperature.
Latched IN	The valve will open to admit hot air. If no hot air is required - possibly in the flight deck, galley and rear fuselage zones - the valve will remain shut but no lamp will be illuminated.
Latched OUT	The valve will lock shut and CLOSE is illuminated. NOTE: Automatic temperature control is dependent upon at least one Trim Valve switch being latched in.
Power Failure	The valve remains in its last position.

ZONE TEMPERATURE SELECTOR (5)

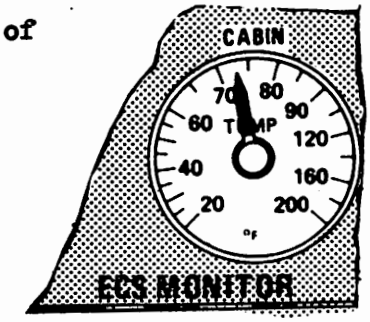
Purpose	It selects the required zone temperature. The 12 o'clock position will give a temperature of approximately 73°F (23°C).

FLOOR HEAT SWITCH

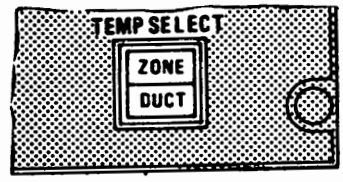
Associated MWS	With FAIL illuminated. ECS
Normal Position	Latched IN.
Normal Indication	Extinguished.
Purpose	It energises the electric floor heating.
Abnormality	Any failure of the floor heating will illuminate the MWS and FAIL lamp and de-energise the heaters. To reset the system the switch must be cycled OFF/ON.
Latched OUT	The heaters are de-energised and OFF is illuminated.

CABIN TEMPERATURE INDICATOR

This indicates the temperature of the selected zone or duct.



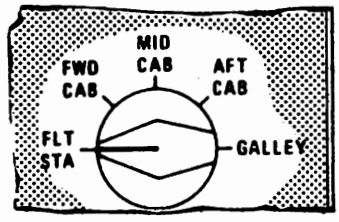
ZONE/DUCT SELECTOR



Latched IN	DUCT is illuminated. The selected compartment duct temperature is indicated.
Latched OUT	ZONE is illuminated. The selected compartment air temperature is indicated.

ZONE SELECTOR

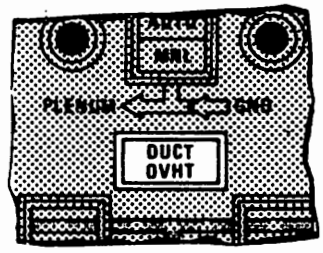
This selects the compartment to be monitored.



DUCT OVERHEAT

Normal Indication

Extinguished.



Operation

A sensor is located in the ducting at the junction of Nos. 2 and 3 hot air ducts.

If an overheat occurs the lamp is illuminated and both isolation valves and hot air valves are locked shut, flowbars extinguished.

When the temperature decreases, the lamp will extinguish but the isolation and hot air valve switches must be cycled OFF/ON to reopen them.

Note that there is <u>NO</u> associated MWS with this warning.

ENVIRONMENTAL CONTROL SYSTEM

CARGO HOLD HEATING

SYSTEM DESCRIPTION

The cargo compartments are heated by blowing air across heat exchangers which use the engine bleed air ducting as a heat source.

The forward and mid compartments are maintained at 65°F (18°C) by a thermostatically controlled fan.

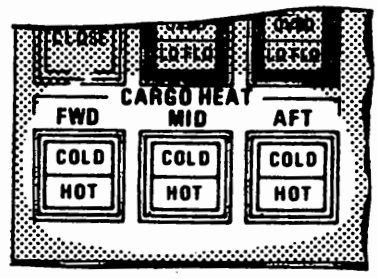
The rear compartment temperature can be selected to 50°F, 55°F, 60°F or 65°F by a selector in the roof of the compartment.

Warning is given of compartment under or overheat.

The forward and mid compartments are not ventilated but the aft one is.

CONTROLS AND INDICATORS

CARGO HEAT SWITCHES



Associated MWS

With HOT illuminated.

Normal Position

Latched IN.

Normal Indication

Extinguished.

Latched IN

The fan is controlled by the thermostat.

If the temperature drops below limits, COLD is illuminated.

If the temperature rises beyond limits, HOT and the MWS are illuminated. When HOT is illuminated the fan is automatically switched off.

Latched OUT

The fan is switched off.

The COLD lamp remains armed and will illuminate if the temperature drops below limits.

AVIONIC BAY COOLING

SYSTEM DESCRIPTION

The cooling of each avionic bay is provided by a continuously running fan which draws air through the equipment.

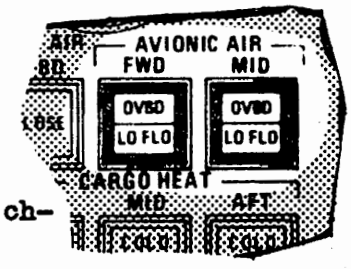
On the ground, the cooling air is exhausted direct to atmosphere but in flight, the overboard valve is shut and the air is exhausted to the forward underfloor area and thence via the normal discharge valve to atmosphere.

Indication of inadequate airflow and the position of the overboard valve is provided.

CONTROLS AND INDICATORS

AVIONIC AIRFLOW INDICATORS

Associated MWS when illuminated.



These are indicators and not switch-lights.

LO FLO This is illuminated when the airflow is restricted or too hot.

OVBD This is illuminated when the overboard valve is open.

The valve will open:-

(a) When the aircraft is on the ground.

(b) If the duct airflow is inadequate (due to a blockage or a fan failure)

AFT CARGO VENT SYSTEM

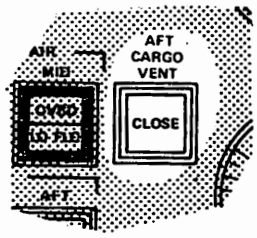
SYSTEM DESCRIPTION

The compartment is ventilated by a fan which blows cabin air through an inlet valve into the hold, and a flow control valve which controls the discharge to atmosphere. (Thus eliminating the possibility of disagreeable animal odours offending the rear cabin passengers).

Provision is made to shut the flow control valve and open an alternative bypass valve.

In the event of a smoke warning the compartment can be completely sealed.

CONTROLS & INDICATORS



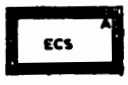
AFT CARGO VENT SWITCH

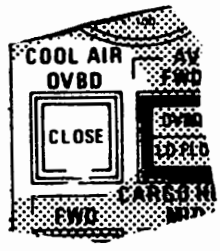
Normal Position	Latched IN
Normal Indication	Extinguished
Normal Operation	Compartment air is introduced by the fan and discharged via the flow control valve to atmosphere.
Abnormal Operation	
LATCHED OUT	If the AFT CARGO VENT switch is latched out, the inlet valve, flow control valve and bypass valve are all shut the fan is switched off, thus completely sealing the aft cargo hold. This will occur automatically following an aft aft cargo hold smoke warning.

GALLEY VENTING

SYSTEM DESCRIPTION	The galley ovens are vented by a continuously running fan and a normally open overboard valve.

COOL AIR OVBD SWITCH

SYSTEM DESCRIPTION	This switch will close all cooling and ventilation discharge valves (except the main pressurisation outflow valves).
Associated MWS with CLOSE	



Normal Position	Latched IN
Normal Indication	Extinguished.
Normal Operation	The galley, avionics and aft cargo valves respond to normal operation.
Abnormal Operation	When the switch is latched out all valves will shut. The galley ovens will not be ventilated (although the fan will continue running). In flight the avionics cooling will be unaffected (unless a fan is defective). The aft cargo ventilation will be unaffected but the air will be discharged to the cabin underfloor area, via the bypass valve.

SMOKE WARNING

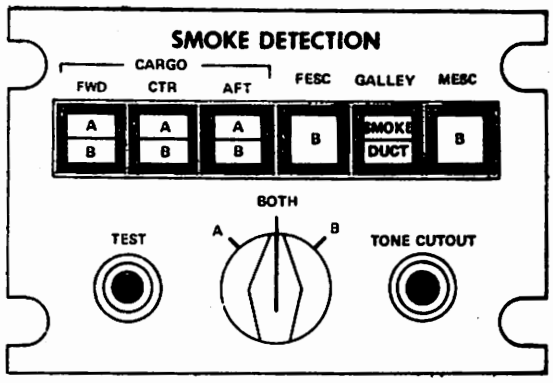
The operation of the accompanying warnings, loop systems, smoke detector unit and system testing is described in Fire Protection, Section

CARGO SMOKE WARNING

FWD and CTR

The forward and centre compartments are not ventilated.

The closed circuit airflow can be stopped circulating by latching OUT the appropriate CARGO HEAT switches.



AFT

Ventilation is stopped and the compartment is sealed automatically, and confirmed by latching OUT the AFT CARGO VENT switch.

GALLEY

The galley smoke warning is divided into two displays.

SMOKE

This warning is introduced by smoke in the galley.

DUCT

This warning is introduced by an overheat (fire) in the galley oven vent duct.

It will be accompanied by a fire bell and duct overheat lamp in the galley, plus flight deck smoke warnings.

The galley bell can be silenced by a mute switch on a panel adjacent to the galley external door.

Procedure for DUCT warning

The galley power should be switched off, the oven dampers pushed down, the nozzle of the $C.O._2$ extinguisher inserted into an access panel and the bottle discharged.

Testing

The duct overheat warning can be tested by pressing the ALARM TEST switch in the galley.

This will introduce the flight deck and galley warnings.

The duct test is armed only while the aircraft is on the ground.

ENVIRONMENTAL CONTROL SYSTEM

PRESSURISATION

SYSTEM DESCRIPTION

Automatic cabin pressurisation is achieved by a combination of a pressure controller and a pair of outflow valves, one being located at the front and the other at the rear of the aircraft. The outflow valve operation is arranged so that the forward valve is the first to open and last to close, thus ensuring an adequate cooling airflow for the forward and mid electronic bays. The pressure controller can be set to give the normal maximum differential of 8.44 at flight altitude or any lower differential pressure.

Standby control of cabin pressure is provided, with the additional facility of a cabin height "lock". Under a standby control there is no automatic control of the normal maximum differential pressure.

Direct control of each outflow valve is provided via alternative circuits and actuators.

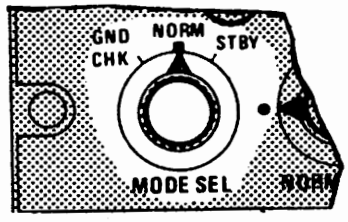
Safety valve setting is 8.75 and inward relief valves minus 0.15.

CONTROLS AND INDICATORS

MODE SELECTOR

GND CHK - This overrides the oleo switches to permit the system to be checked.

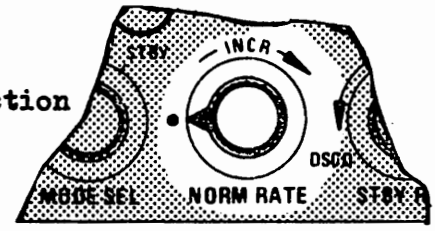
NORM - The normal switch position. The system will be automatically controlled to satisfy the rate and altitude selections.



STBY - Standby Control. Automatic selection of cabin altitude is lost but maintenance of existing cabin altitude is available. (Variations of cabin altitude are made using the standby rate selector)

NORMAL RATE SELECTOR

This controls the rate of change of cabin altitude (while the mode selector is at NORM,)



The full anti-clockwise selection gives:-

120 FPM descending
200 FPM climbing

The full clockwise (INCR direction) gives:-

900 FPM descending
1500 FPM climbing

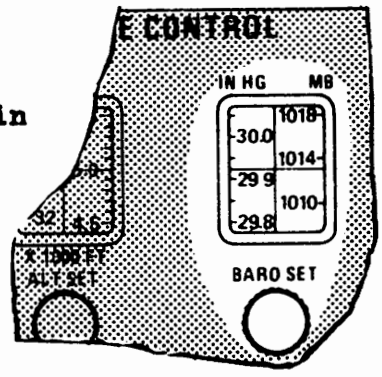
The index mark (9 o'clock) gives:-

300 FPM descending
500 FPM climbing

BAROMETRIC SELECTOR

This is used to set the datum of the pressure controller within the limits of

900 - 1050 M/B



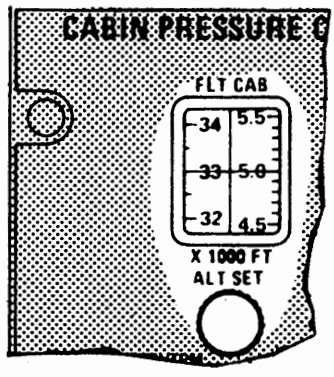
ALTITUDE SELECTOR

This is used to set the aircraft flight altitude between 20,000 ft and 50,000 ft.

The corresponding cabin altitude, at a D.P. of 8.44, is opposite the flight altitude.

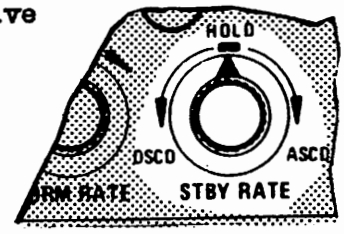
The cabin altitude range is from minus 1,000 to 10,000 ft.

Both the Barometric and Altitude selectors are effective only when the mode seleetor is set to NORM.



STANDBY RATE SELECTOR

This selector provides alternative control following a failure of the normal system.



The selector is effective only when the mode selector is set to STBY.

DSCD - the cabin will descend at a rate of 0 to 1000 FPM.

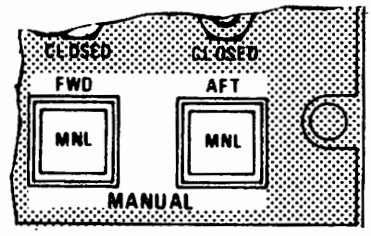
ASCD - the cabin will climb at a rate of 0 - 1000 FPM.

HOLD - the cabin altitude will be maintained.

When controlling by the standby selector, there is no automatic control of the normal D.P. of 8.44. Mis-selection will result in the D.P. increasing to 8.75 at which it will be automatically controlled by the safety valves.

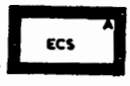
AUTO/MANUAL SELECTOR SWITCHES (2)

These select the form of control of the outflow valves.



Associated MWS

With MNL illuminated.



Normal Position

Latched OUT

Normal Indication

Extinguished.

Latched OUT

The outflow valves are controlled automatically, either under the control of the normal altitude and rate selectors, or by the standby rate selector.

The valves are fully opened when the aircraft is on the ground with the mode selector at NORM only.

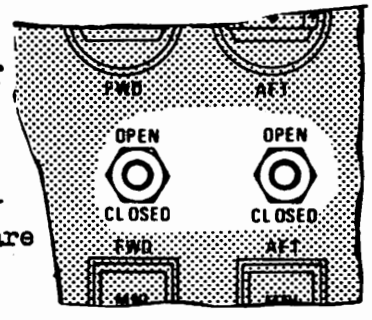
Latched IN

The MWS and white MNL is illuminated.

The outflow valves are controlled by the MANUAL SWITCHES.

OUTFLOW VALVE MANUAL SWITCHES (2)

These provide direct control of the outflow valves via D.C. actuators.



The switches are effective only when the auto-manual switches are latched IN.

The switches are sprung to the central, off, position.

The valve movement is slower than when controlled automatically.

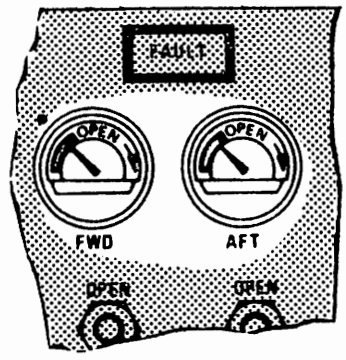
OUTFLOW VALVE POSITION INDICATORS (2)

These indicate the position of the outflow valves.

Normally the valve will remain within the green sector.

An index mark at the 10 o'clock position on the forward indicator represents the point up to which both valves close simultaneously.

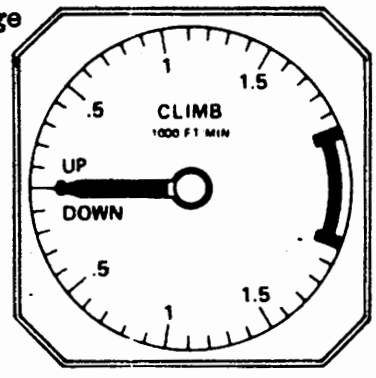
Any additional closure is met by the aft valve only until it is fully shut. This ensures an adequate cooling airflow for the forward electronic bays.



MONITOR GAUGES

CABIN RATE OF CLIMB INDICATOR

This indicates the rate of change of cabin altitude.



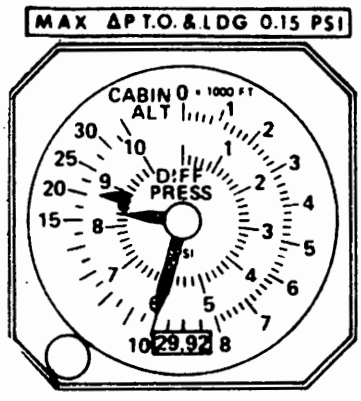
CABIN ALTIMETER AND DIFFERENTIAL PRESSURE GAUGE

The millibar scale is set by the knob in the L.H. lower corner.

The short inner pointer indicates the cabin differential pressure.

A yellow mark emphasises a pressure between 8.44 and 8.5.

A red mark indicates a pressure between 8.5 and 8.83.



ABNORMALITIES

CABIN ALTITUDE WARNINGS

Cabin Pressure MWS

If the cabin altitude exceeds 10,000 ft, the RED MWS

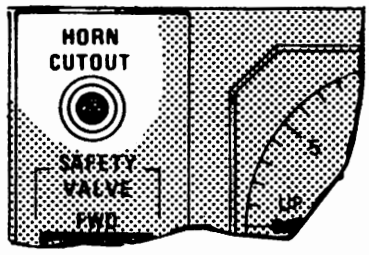
is introduced.

Cabin Altitude Horn

If the cabin altitude exceeds 12,000 ft. the intermittent horn is introduced.

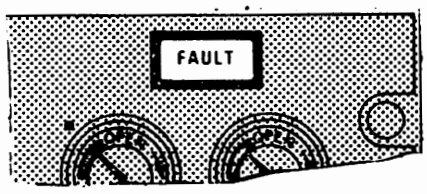
Horn Cut-out Switch

The horn can be cancelled by pressing the cut-out switch.



OUTFLOW VALVE FAULT LAMP

Associated MWS



Normal Indication

Extinguished.

Operation

The warning is introduced by two conditions:-

(a) If either outflow valve is open beyond the 12 o'clock position with the aircraft altitude exceeding 15,000'.

Under this condition both valves are locked in their position.

They must be closed by:-

(i) Selecting both auto/manual switch to MNL (Latching IN).

(ii) Using the manual control switch, move the affected valve into the normal range (A selection of CLOSED)

When both valves are within the normal range the FAULT lamp will extinguish.

(b) A cabin altitude exceeding 11,500 ft.

Under this condition the outflow valves will automatically control the cabin altitude at 11,500 ft.

Normal operation is achieved by selecting the auto/manual switches to MNL and using the manual switches.

OVERPRESSURISATION

SAFETY VALVE LAMPS

Associated MWS

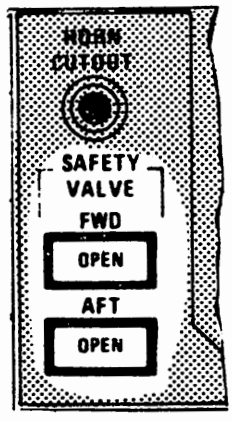
ECS

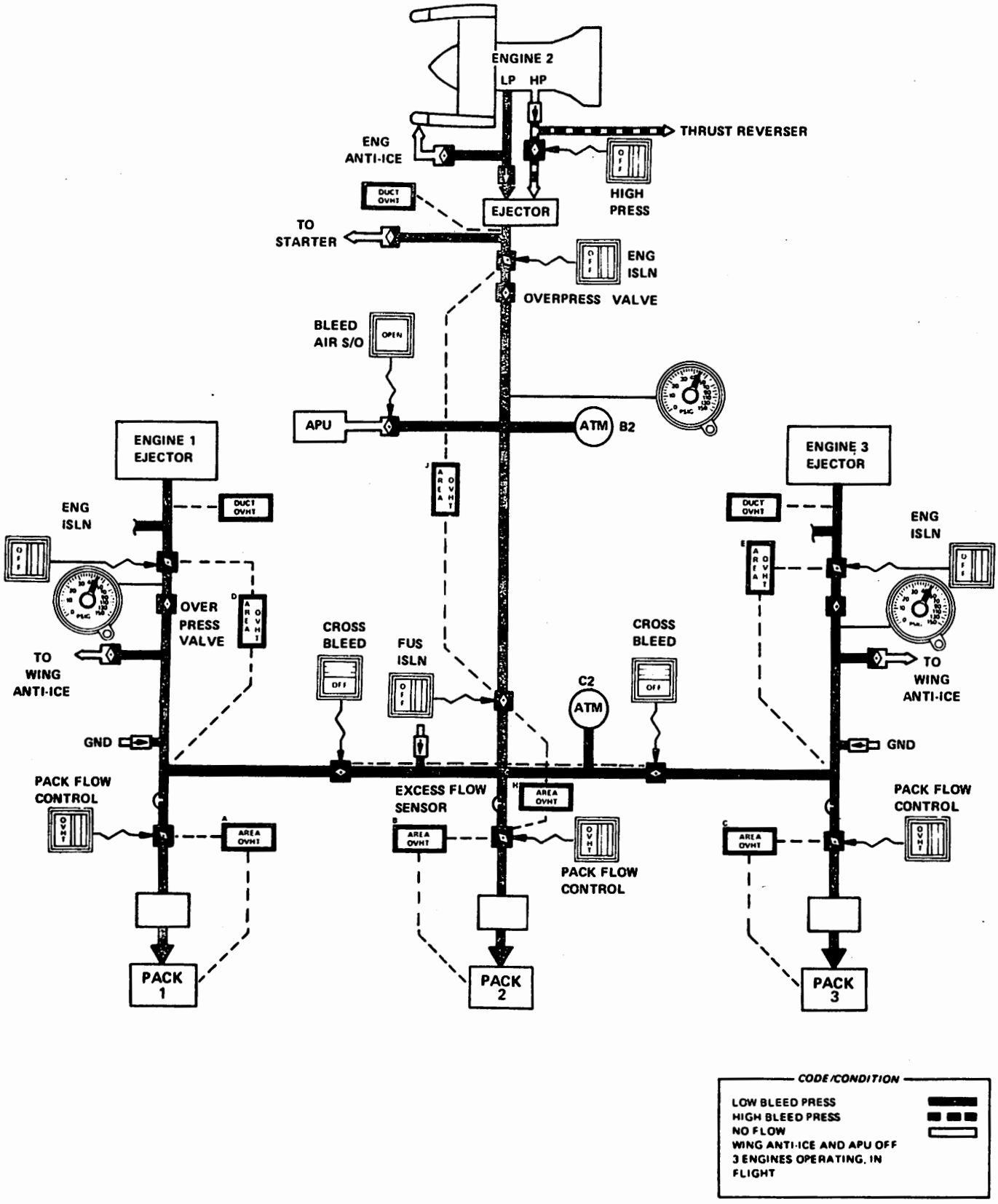
Operation

The maximum differential pressure is limited to 8.75 by two safety valves.

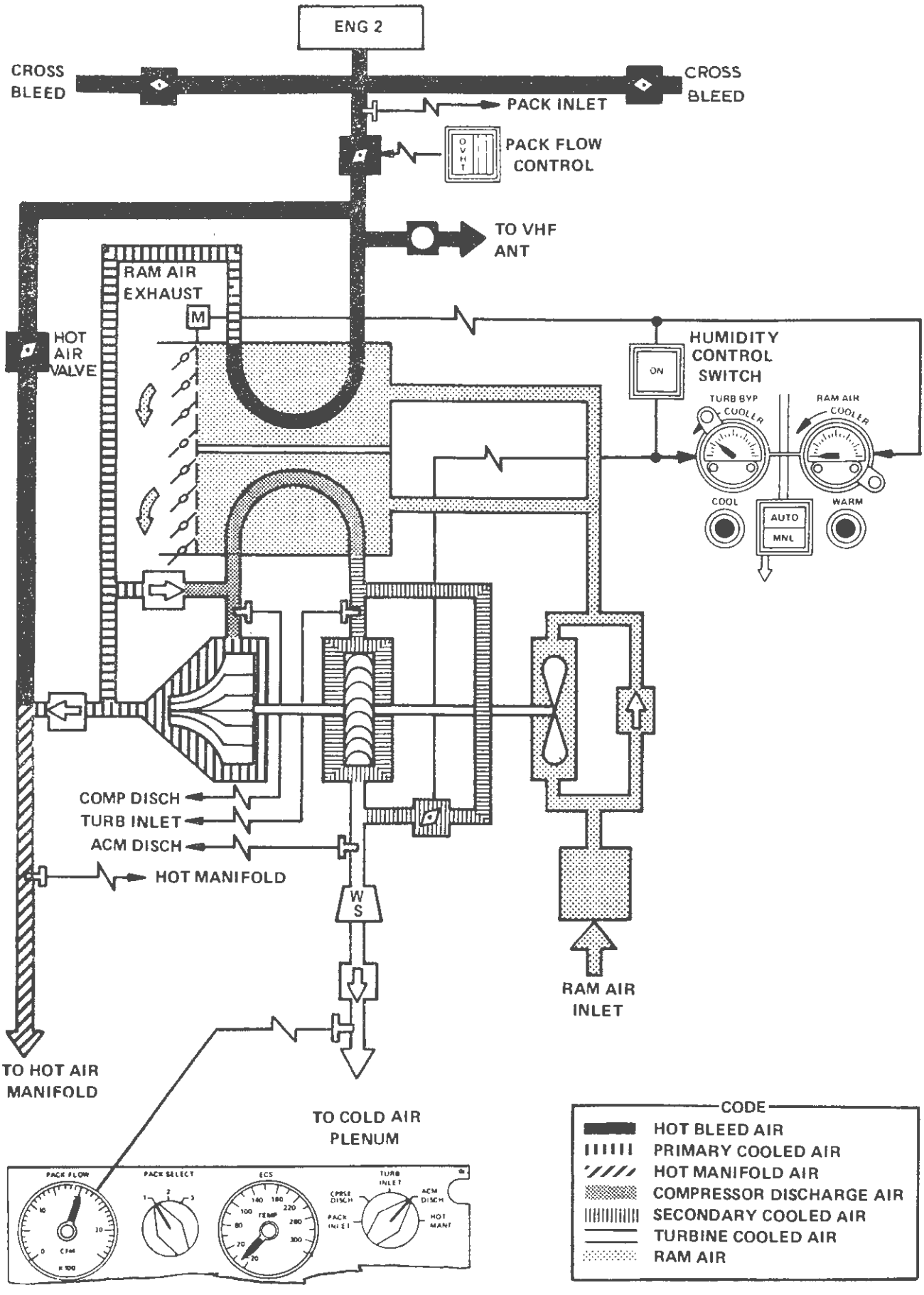
Whenever a safety valve opens, the appropriate lamp and MWS is illuminated.

As the valve shuts, the lamp is extinguished.

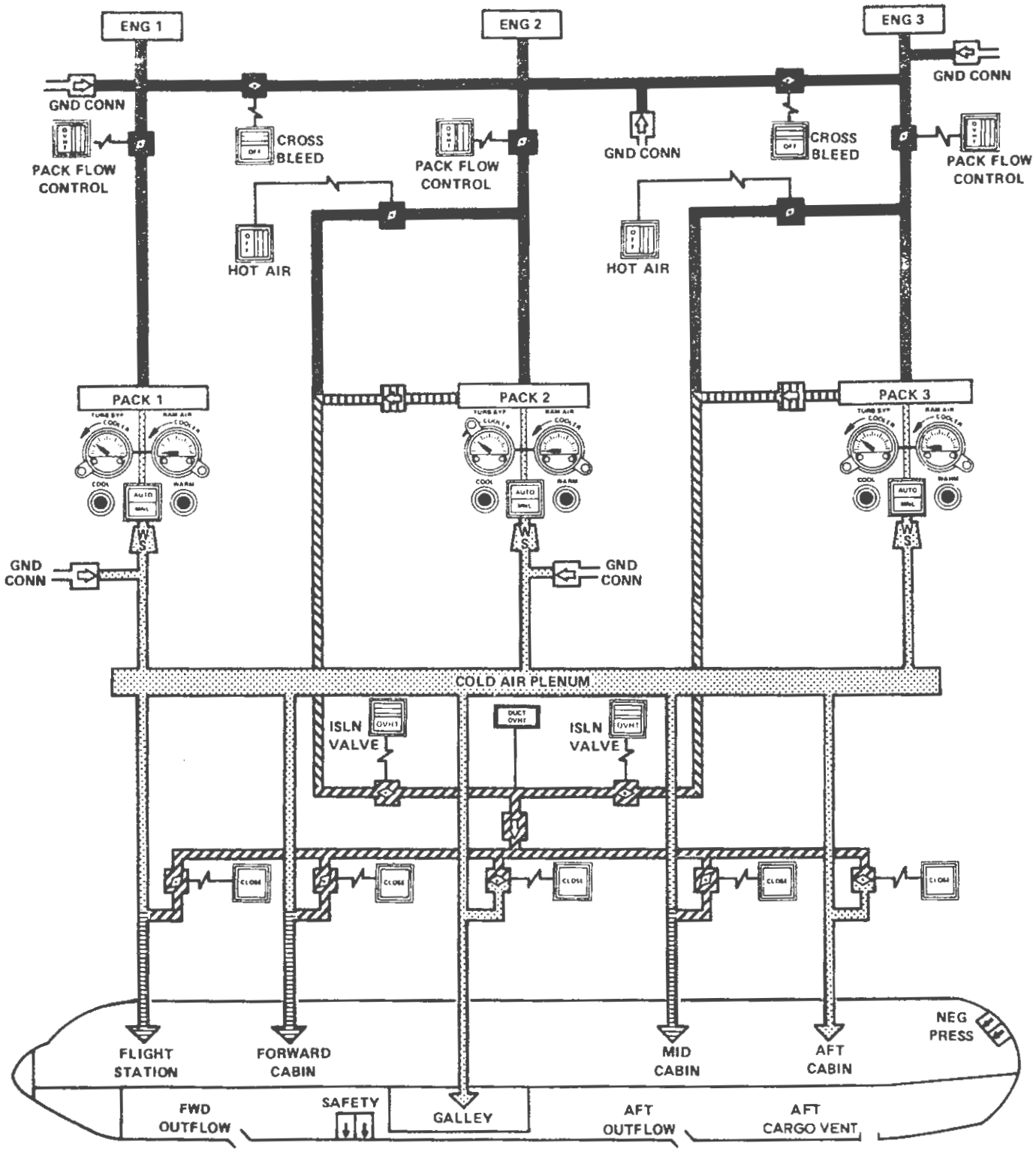




BLEED AIR SYSTEM



AIR COOLING SYSTEM



CABIN TEMPERATURE CONTROL

Summary of ECS Abnormal Indications

FAULT	MWS DISPLAY	PANEL DISPLAY	AUTOMATIC ACTION	PROCEDURE
Nacelle/Pylon overheat	NACELLE No. OVHT 1,2 or 3	Loop A & B lights 1,2 or 3	HI PRESS valve locks shut	Continue on IP air
Bleed duct overheat	AREA/DUCT OVERHEAT	DUCT OVHT 1,2 or 3	HI PRESS valve ENG ISLN VALVE locks shut	Re-open engine isolation valve if possible.
Single area overheat	AREA/DUCT OVERHEAT	AREA OVHT A,B,C,D,E,J, H.	NIL	Close the valves surrounding the lamp.
Triple area overheat (Forward cargo Hold)	AREA/DUCT OVERHEAT	AREA OVHT A & B & C	NIL	Close the pack flow control valve of the leaking system
Bleed duct overpressure	NIL P_3 ANNUNCIATOR BLEED DUCT OVERPRESS	NIL	ENG ISLN VALVE locks shut	Close high press valve & re-open engine isolation valve.
Excess flow lockout	NIL	NIL	No. 1 or 3 ENG ISLN CROSS BLEED PACK FLOW No.2 AFT FUS ISLN BOTH CROSS BLEEDS PACK FLOW	
Pack overheat	ECS	O V H T 1 or 2 or 3	PACK FLOW CONTROL locks shut	Determine fault Manual WARM/COOL as required.
Hot air duct overheat	NIL	DUCT OVHT	Both HOT AIR valves Both ISLN VALVES lock shut	Try to restore partial hot air supplies
FESC overheat	ECS	OVHT Both ISLN VALVES	Both HOT AIR valves Both ISLN VALVES lock shut	

FAULT	MWS DISPLAY	PANEL DISPLAY	AUTOMATIC ACTION	PROCEDURE
Floor heat fail.	ECS	FAIL Floor heat switch	Floor heat is switched off.	Switch off floor heat.
Cargo heat overheat	ECS	HOT FWD/MID/AFT	Heater fan is switched off	Switch off cargo heat
Avionic airflow failure	ECS	LO FLO.	OVBD valve opens	If LO FLO remains lit, switch off avionic equip.
Cool air overboard valve closure.	ECS	CLOSE		All overboard valves are closed.

HYDRAULICS

CONTENTS

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Hydraulic Power	1 - 8
Undercarriage	9 - 14
Brakes	15 - 19
Schematic Diagrams	20 - 22

HYDRAULICS

INTRODUCTION

The aircraft hydraulic system is conventional, consisting of four independent constant pressure systems, A, B, C and D pressurised to 3,000 P.S.I. by engine driven pumps (E.D.P.s).

B and C pumps are driven by No.2. engine and are backed up by air turbine motor pumps (A.T.M.s).

A and D pumps are driven by Nos. 1 and 3 engines, and are backed up by power transfer units (P.T.U.s) that use B and C systems as a power source.

Under extreme failure conditions, a ram air turbine (R.A.T.) can be used to pressurise B system.

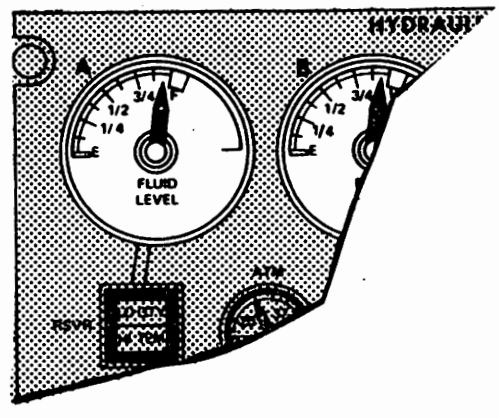
The distribution of the hydraulic power is:-

Primary Flight Controls	-	All four systems, with 'B' common to all flight controls.
Lift Augmentation	-	A and C
Undercarriage and Steering	-	C
Brakes	-	B and C

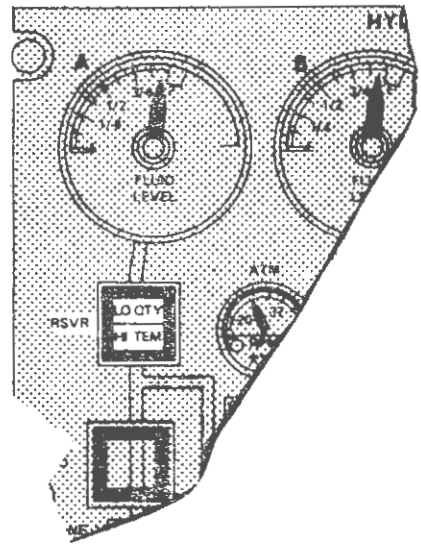
CONTROLS AND INDICATORS (Upper Systems Station)

FLUID LEVEL GAUGES (4)

Normal Indication — Green sector ($\frac{3}{4}$ to FULL)



RSVR LO QTY and HI TEM LAMPS (4)



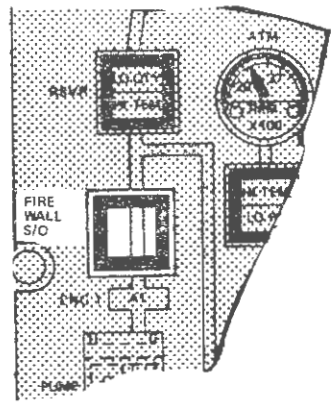
Associated MWS (With LO QTY and HI TEM)

Normal Indication — Extinguished.

LO QTY — Illuminated when the reservoir contents drop below approximately $\frac{1}{8}$ FULL.

HI TEM — Illuminated when the reservoir fluid temperature becomes excessive.

FIRE WALL S/O LAMP (4)



Normal Indication — Flowbar illuminated.

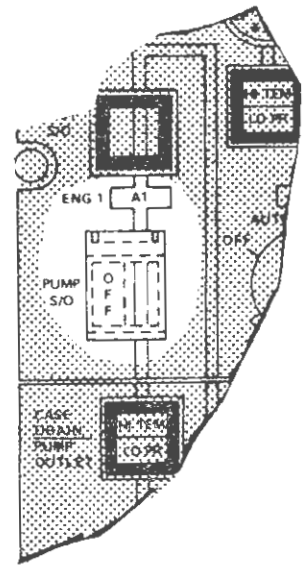
Operation — Normally fluid passes from the reservoir to the pump via the open firewall shut-off valve.

When the FIRE PULL handle is pulled the suction shut-off valve automatically closes.

As the valve begins to close, the flowbar extinguishes and a blue in-transit lamp is illuminated to indicate that the valve is not in the selected position.
When fully closed the in-transit lamp is extinguished.

If the FIRE-PULL handle is re-positioned IN, the valve will re-open and the indicating sequence will be reversed.

PUMP S/O SWITCH (4)



Normal Position — Latched IN.

Normal Indication — Flowbar illuminated.
OFF extinguished.

OFF indicates switch position.

Latched IN — Normally the pump output is delivered to the system.

When the FIRE PULL handle is pulled, the pump shut-off valve automatically closes and the EDP pump delivery to the system is shut off.

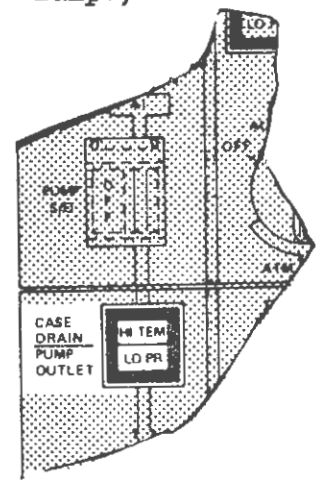
Under this condition the flowbar remains illuminated.

Latched OUT — The shut-off valve is closed, the pump goes to minimum output and the flowbar is extinguished.

OFF is illuminated.

LO PR warnings are extinguished.
(See EDP case drain and pump outlet lamps)

EDP CASE DRAIN AND PUMP OUTLET LAMPS (4)



Associated MWS (with HI TEM and LO PR)

Normal Indication — Extinguished.

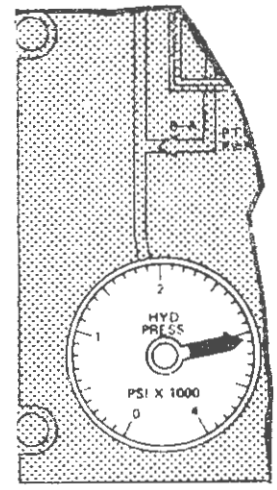
These lamps are armed when the pump shut-off switch is latched IN.

HI TEM — Illuminated when the EDP delivery temperature is excessive.

LO PR — Illuminated when the EDP delivery pressure falls to 700 P.S.I.

Note that these warnings are associated with pump output and not system pressure.

HYD PRESS GAUGES (4)



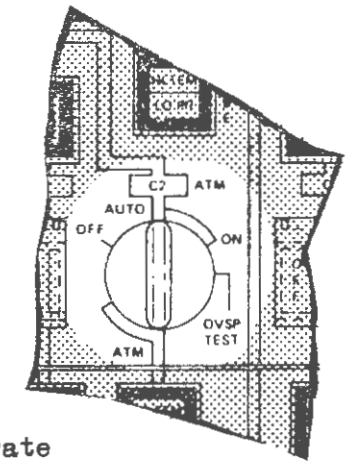
Normal Indication 2850 to 3075 P.S.I.

Note that these gauges indicate system pressure.

System Pressure Relief 3400 - 3560 psi

ATM SELECTOR SWITCHES (2 B and C systems)

Normal Position AUTO



OFF ATM shut down.

AUTO The ATM will automatically run to support the main system if the delivery pressure falls to 2600 P.S.I.

Once started, the ATM will continue running for 17 seconds.

'C' system ATM will normally operate during undercarriage retraction.

An overspeed device will shut down the ATM at 125% of NORMAL R.P.M.

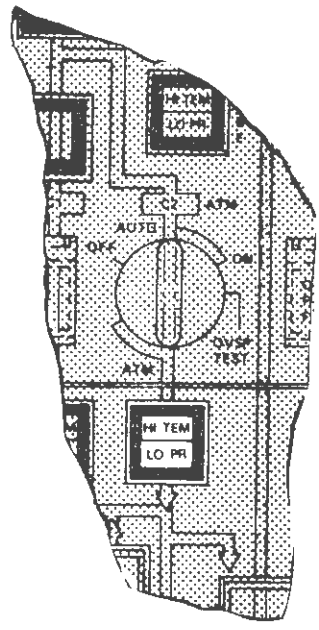
ON The ATM will run continuously.

Note The position of the EDP suction and delivery valves do not affect ATM operation.

OVSP TEST An overspeed signal is introduced into the control system and the ATM will shut down.

To reset the system the switch must be selected OFF and the appropriate C/B tripped and re-set.

ATM CASE DRAIN AND PUMP OUTLET LAMPS (2 B & C systems)



Associated MWS (with HI TEM and LO PR)

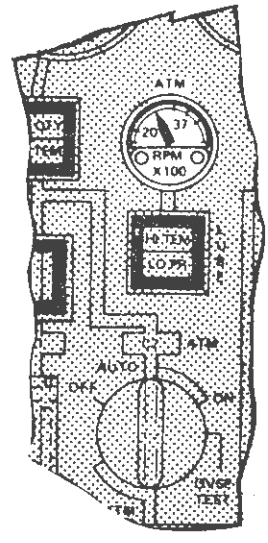
Normal Indication — Extinguished.

These lamps are armed only when the ATM switch is selected to ON or OVSP TEST.

HI TEM — Illuminated when the ATM delivery temperature is excessive.

LO PR — Illuminated when the ATM delivery pressure falls to 700 P.S.I.

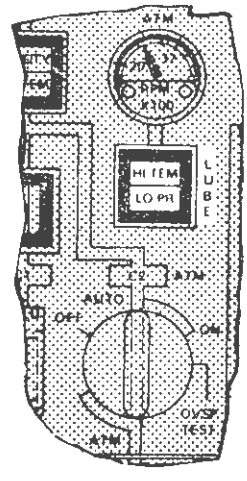
ATM RPM INDICATOR (2 B & C systems)



Normal Indication — 3700 with the ATM running.
0 with the ATM stopped.

ATM LUBE LAMPS (2 B & C systems.)

Associated MWS (with HI TEM and LO PR)



Normal Indication — Extinguished.

The LO PR lamp is armed when the switch is selected to ON, or AUTO with a RUN signal.

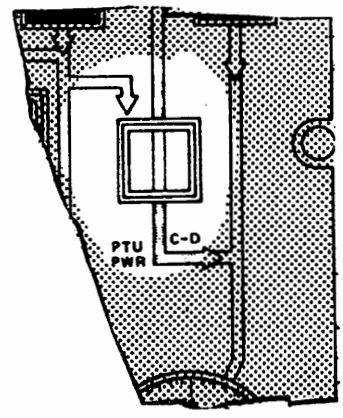
HI TEM — The HI TEM warning is always armed.

This is illuminated when the ATM lubrication oil temperature is excessive.

LO PR — Illuminated when the ATM lubrication oil pressure falls below limits.

PTU PWR SWITCHES. (2 A & D systems)

Momentary switches.



Normal Indication — Flowbar extinguished.
The flowbar indicates switch position only.

Pressing — The control valve is opened and System A (or D) is pressurised by a power transfer unit that is operated by system B (or C).

The output of the PTU is flow controlled, therefore the pressure will vary depending upon system demand.

With no demand, A and D pressures will cycle between 2500 and 2700 PSI.

The flowbar is illuminated.

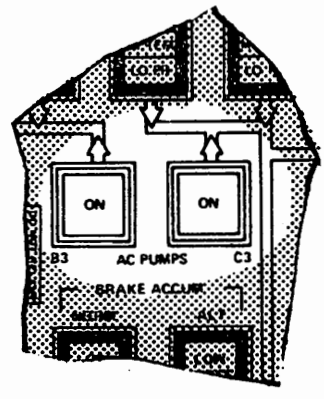
Re-pressing — The P.T.U. is de-energised.
The flowbar is extinguished.

The position of the EDP suction and delivery valves do not affect the P.T.U. operation.

A.C. PUMP SWITCH (2 B & C systems)

Normal Selection — Latched OUT

Normal Indication — Lamp extinguished.



Latched IN — The A.C. pumps pressurise B or C systems within the range of 1500 to 3000 P.S.I. depending upon demand.

The ON indication is illuminated.

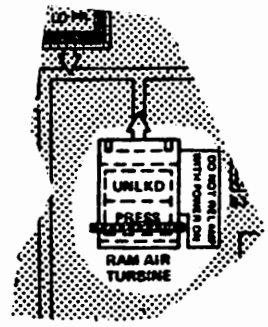
Latched OUT — The A.C. pump is de-energised.
The lamp is extinguished.

NOTE

1. The position of the E.D.P. suction and delivery valves do not affect the A.C. pump operation.

2. The output of the A.C. pumps is very low, their purpose being mainly for ground servicing of the aircraft.

RAM AIR TURBINE SWITCH (B system only)



Associated MWS (with UNLKD)

Normal Indication Extinguished.

Pressing With the aircraft in flight, pressing the spring-loaded switch will fire an explosive charge to unlock the R.A.T. which extends and pressurises 'B' system.

Indication Amber UNLKD is illuminated when the uplock is released.

Green PRESS is illuminated when the R.A.T. output is satisfactory.

Automatic RAT Extension Automatic extension is achieved by electrical release of the uplock, the explosive charge <u>not</u> being used.

Two sets of conditions will automatically extend the RAT:-

1. (a) Aircraft in flight and
   (b) I.A.S. above 100K and
   (c) all three engines less than flight idle RPM

or

2. (a) Aircraft in flight and
   (b) all four hydraulic pumps switched off and,
   (c) both ATM selectors OFF.

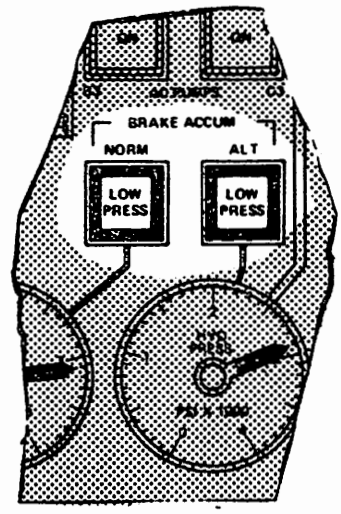
RAT extension is inhibited when the aircraft is on the ground. However, when with ground power OFF, RAT switch operation will fire the charge and extend the RAT.

To prevent such accidental operation, a safety lock can be fitted to the RAT stowage.

BRAKE ACCUMULATOR LAMPS (2 B and C systems)

Associated MWS

(with LOW PRESS)



Normal Indication — Extinguished.

Abnormal Indication — When a brake accumulator pressure falls below 1500 PSI the appropriate lamp is illuminated.

(A non-return valve prevents the brake accumulator feeding into a depressurised main system)

HYDRAULIC SYSTEM
NORMAL OPERATION

Before engine starting. The reservoirs are pressurised by a piston that is operated by system pressure. To prevent EDP or ATM pump cavitation, the systems should be pressurised using the AC pumps and PTUs, before ATM running or engine starting.

After engine starting. As each engine is started the appropriate pump outlet LO PR lamp will extinguish and the system pressure will stabilise at 3000 P.S.I.

ATM Check Procedure

1.

ATM switch	ON
R.P.M.	3700
LUBE lamps	EXTINGUISHED
CASE DRAIN lamps	EXTINGUISHED
PUMP OUTLET lamps	EXTINGUISHED

Re-select auto, check that ATM shuts down after 17 secs.

2. If an overspeed test is performed, reset by:-

ATM switch	OFF
ATM C/Bs	TRIP & RESET (2L 13 & 19)
ATM switch	AUTO

After Take-off — As the undercarriage is selected UP, C system ATM will operate to assist in undercarriage retraction.

UNDERCARRIAGE

INTRODUCTION

The undercarriage consists of two sideways retracting main units, a forward retracting steerable nose unit and a tail skid.

Each mainwheel assembly is fitted to a truck (bogie) which is automatically levelled before retraction.

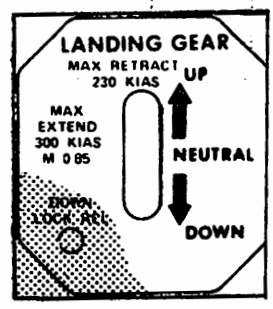
Hydraulic power for undercarriage and main door operation, truck levelling and nosewheel steering is provided by 'C' system. The tail skid operation is by 'A' system.

There are two alternative methods of lowering the undercarriage.

CONTROLS AND INDICATORS

UNDERCARRIAGE SELECTOR LEVER (RH side of Centre Instrument Panel)

DOWN (From UP or NEUTRAL) - Doors open.
Undercarriage extends.
Downlocks engage.
Doors close.



When a truck is tilted or an oleo is in a GROUND condition a baulk is introduced to lock the selector in the DOWN position.

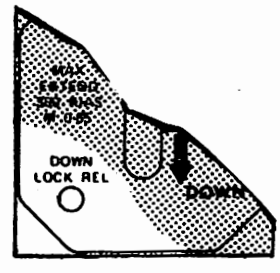
UP (From DOWN) - Doors open.
Undercarriage retracts.
Doors close and lock.

NEUTRAL (From UP) - Hydraulic supply to the undercarriage is shut off.

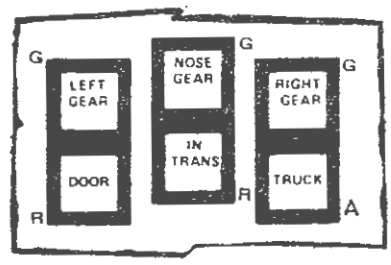
A shut-off valve locks fluid in the undercarriage jacks.

DOWNLOCK RELEASE BUTTON

When pushed, it will over-ride the lever baulk introduced by a tilted truck or an oleo in a ground condition.



UNDERCARRIAGE INDICATORS (Centre Instrument Panel)



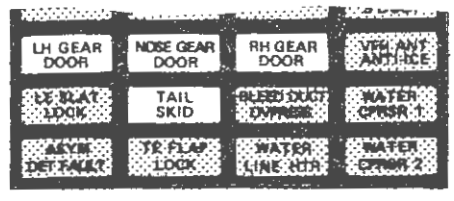
Green GEAR lamps - Illuminated when the appropriate undercarriage is locked down.

Red DOOR lamp - Illuminated when any door is open.

Red IN TRANS lamp - Illuminated when any undercarriage or door is not in the selected position.

Amber TRUCK lamp - Illuminated when either truck is not level.

DOOR AND TAIL SKID INDICATOR (Systems Station Annunciator Panel)



Amber DOOR lamps - Illuminated when appropriate door is not locked shut.

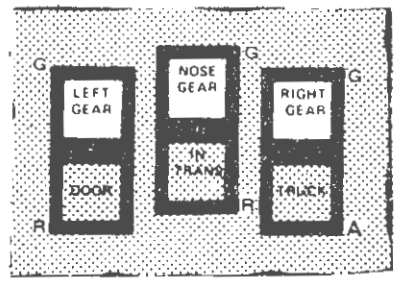
Amber TAIL SKID lamp - Illuminated when:

The tail skid is not in the selected position or is in contact with the ground.

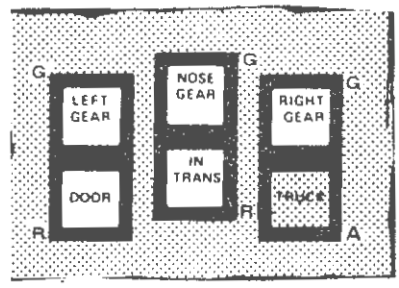
If in contact with the ground, the lamp is latched on.

UNDERCARRIAGE INDICATORS

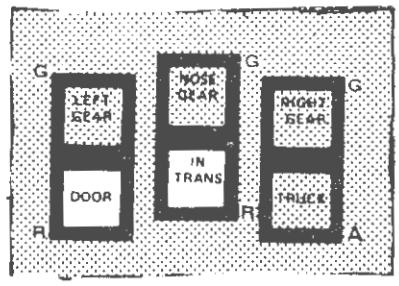
DOWN SELECTED
DOWN ENGAGED



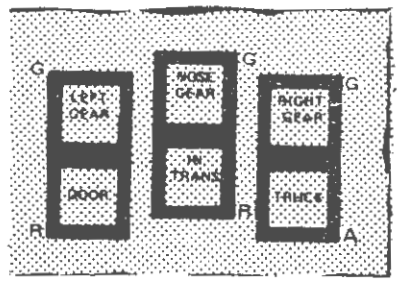
UP SELECTED
DOORS OPENING



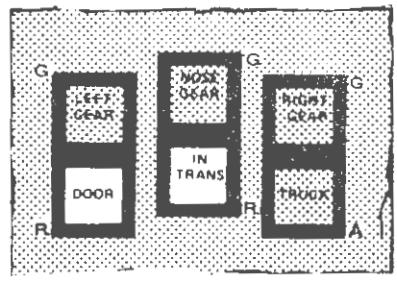
UP SELECTED
U/C RETRACTING



UP/NEUTRAL SELECTED
LOCKED UP



DOWN SELECTED



UNDERCARRIAGE AUDIBLE WARNING

A steady horn will sound if any undercarriage is not locked down and:-

1. Any throttle retarded to idle and the speed is below 190K.

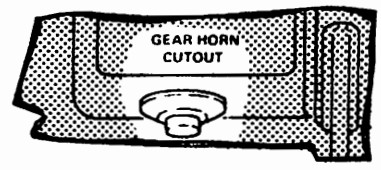
or

2. Flaps are extended more than 30°.

The horn cannot be cancelled during condition 2.

WARNING HORN CUT OUT SWITCH (Rear of Airbrake Selector)

Pressing the switch will cancel the horn if it was introduced by the throttle and speed condition.

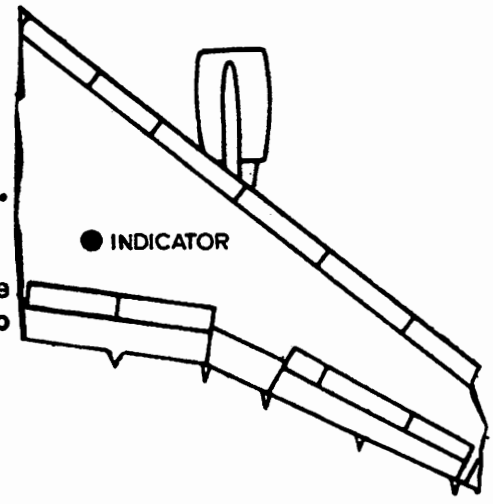


MECHANICAL INDICATORS

MAIN UNDERCARRIAGE

The indicators are visible from the mid cabin windows.

When the downlocks engage, the indicators extend above the wing surface by 2.0" to reveal three red bands.



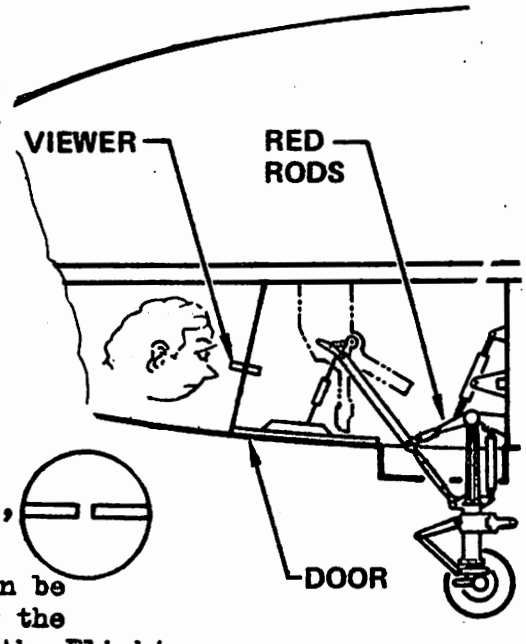
NOSE UNDERCARRIAGE

This indicator is visible through a viewer which is located on the rear bulkhead of the forward electronics bay.

Before looking through the viewer, the dust cover must be removed by operating the lever above the viewer.

When the downlock engages, two red rods align.

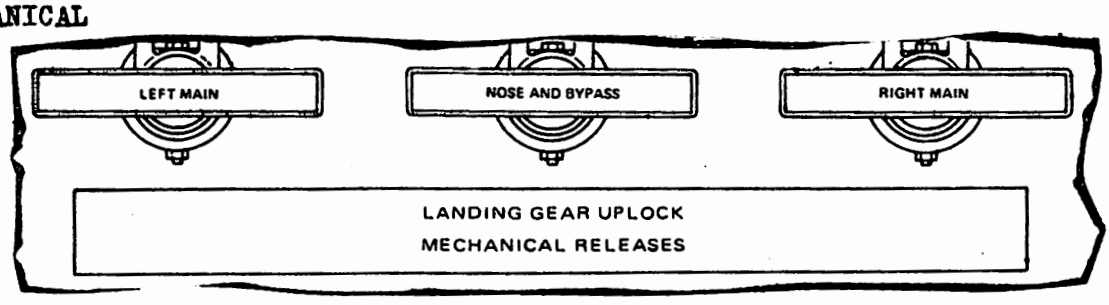
At night, the wheelbay can be illuminated by depressing the WHL WELL light switch on the Flight Deck roof panel.



ABNORMALITIES

Two alternative methods of undercarriage lowering are provided.

UPLOCK MECHANICAL RELEASES



These handles are located on the floor at the rear of the centre pedestal and are normally stowed. They are effective, regardless of the normal undercarriage selector.

NOSE AND BYPASS

Pulling this handle operates a bypass valve in the master undercarriage hydraulic control servo to allow hydraulic fluid to be displaced from the jacks. When pulled it also mechanically releases the nose uplock and the nose undercarriage free falls and locks down, the doors closing normally.

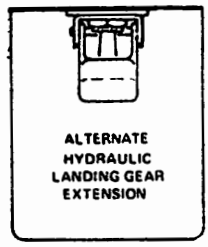
The nose handle should be operated first in order to operate the master bypass valve.

LEFT AND RIGHT MAIN

When pulled it opens a bypass valve in each undercarriage control valve and mechanically releases the appropriate uplock. The appropriate undercarriage free falls and locks down, the doors remaining OPEN.

ALTERNATE EXTENSION SWITCH

A guarded two position switch that is located on the floor, at the left rear of the centre pedestal.



When operated, regardless of the position of the normal undercarriage selector, or the emergency selector levers, 'C' system brake accumulator pressure is used to hydraulically release the uplocks and assist in undercarriage lowering and locking. (The main doors remain OPEN).

The mechanical release handles should be used first thus maintaining 'C' system brake accumulator pressure for braking purposes.

STEERING

DESCRIPTION

Nosewheel steering is operated by 'C' hydraulic system.

67° left and right is provided by a handwheel on the left hand side of the flight deck.

Up to 10° left and right steering can be selected by deflection of the rudder pedals.

Steering handwheel demands will always over-ride rudder pedal demands.

Rudder pedal input to the steering system is automatically disconnected in flight.

BRAKES

INTRODUCTION

The normal brake system is supplied by hydraulic system B, the alternate by system C. Both brake systems are fitted with hydraulic accumulators, but that of C system is approximately three times the capacity of B's.

Either system can be used with or without the anti-skid units.

Indication is provided of anti-skid operation and individual wheel temperatures.

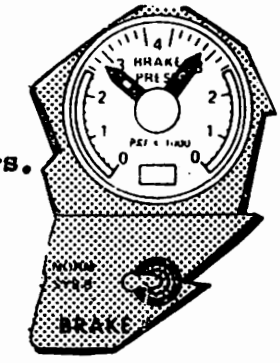
Both brake systems are inhibited when the aircraft is in flight (spin brakes are automatically applied as the undercarriage retracts).

CONTROLS AND INDICATORS

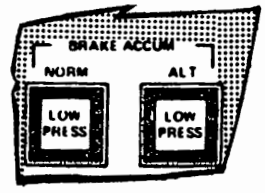
BRAKE PRESS INDICATOR (Centre Instrument Panel)

Indicates the pressure available in B and C system brake accumulators.

Normal pressure is 3000 P.S.I.



BRAKE ACCUM LAMPS (Hydraulic Panel System Station)



Associated MWS with LOW PRESS

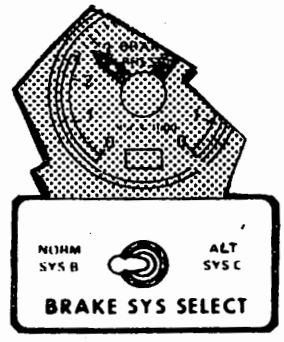
When illuminated, indicate that the appropriate brake accumulator pressure is below 1500 P.S.I.

BRAKE SYS SELECTOR (Centre Instrument Panel)

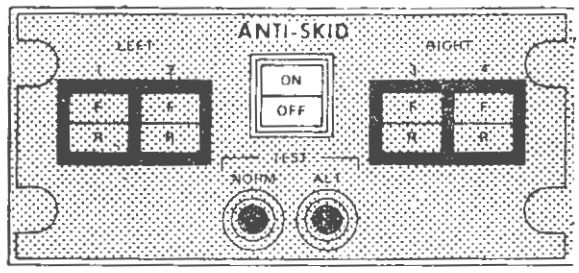
Selects the system supplying the brakes.

Normal Position

NORM SYS B



ANTI-SKID SELECTOR SWITCH



Associated MWS (With OFF)

Normal Position — Latched IN.

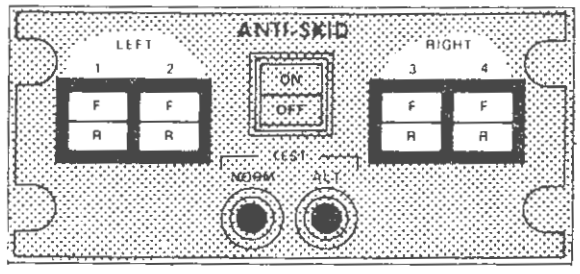
Normal Indication — The green ON lamp is illuminated (unless the hand-brake is applied or the undercarriage is retracted).

Latched IN — Delivery of either system to the brakes is via the anti-skid units, unless the handbrake is applied.

Latched OUT — OFF is illuminated. Hydraulic delivery is direct to the brakes.

NOTE: Anti-skid is inhibited and all lamps are extinguished by an undercarriage UP or NEUTRAL selection.

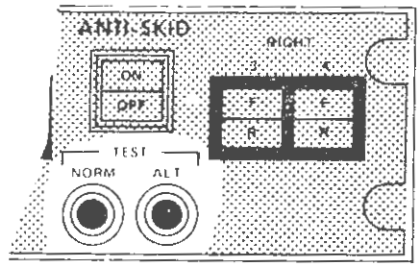
ANTI-SKID LAMPS (Amber) — Each one will illuminate when its associated anti-skid unit has <u>completely</u> released pressure on a skidding wheel.



TEST SWITCHES — Testing of NORM or ALT is valid only if the BRAKE SYS SELECT switch is selected to NORM SYS B.

When pressed, the switches test the anti-skid system.

Serviceable anti-skid systems are indicated by the appropriate anti-skid lamp illuminating.



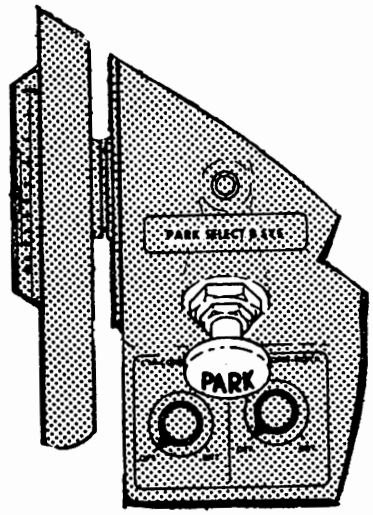
If a lamp fails to illuminate it indicates that the brakes will be applied but the anti-skid system will be inoperative.

PARKING BRAKE (L.H. side of Pedestal)

The parking brake is applied by depressing the rudder pedals and pulling the PARK SELECTOR.

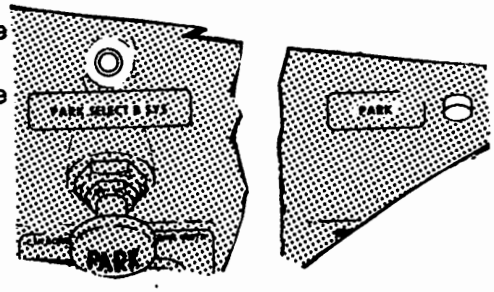
The parking brake is effective in B system only. If parking is selected with C system selected, C system pressure will fall until B automatically takes over.

The application of the parking brake bypasses the anti-skid units, therefore the anti-skid OFF lamps and MWS ANTI-SKID will illuminate.



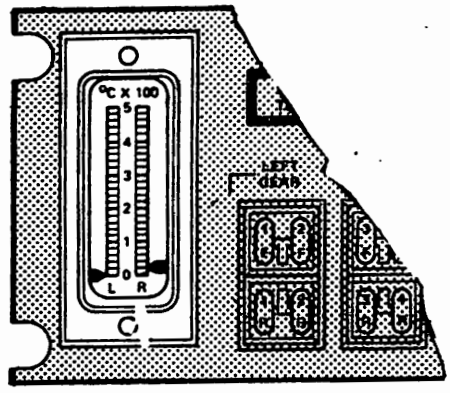
PARK WARNING LAMPS (Red) (End side of Pedestal)

Both lamps will illuminate when the parking brake is applied and the brakes are pressurised.



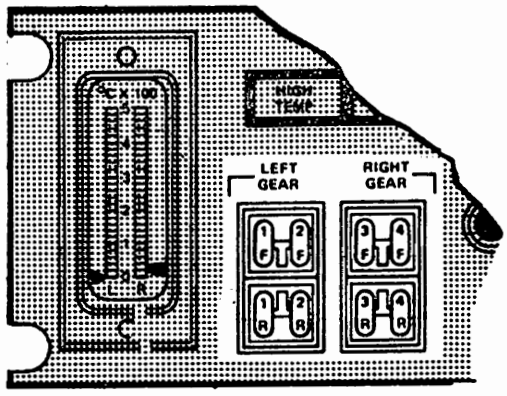
BRAKE TEMP INDICATOR (L.H. side of Upper Systems Station)

This indicates the temperature of the individual brakes selected by the selector switches.



TEMPERATURE SELECTORS

LEFT GEAR
RIGHT GEAR



IN — Lamp illuminated.

Selects the brake temperature to be indicated by the indicator.

OUT — Lamp extinguished.

Indicator reads zero.

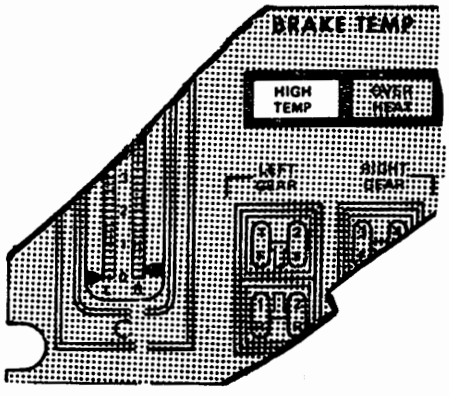
When monitoring temperatures, selector switches should be latched OUT before the next switch is latched IN.

NOTE: The rear brakes normally run 30 to 50°C hotter than the front.

HIGH TEMP LAMP

If all the temperature selectors are latched out the lamp will illuminate when <u>any</u> brake temperature exceeds 275°C.

If the temperature selector is latched IN, the lamp illuminates when the <u>selected</u> brake temperature exceeds 275°C.



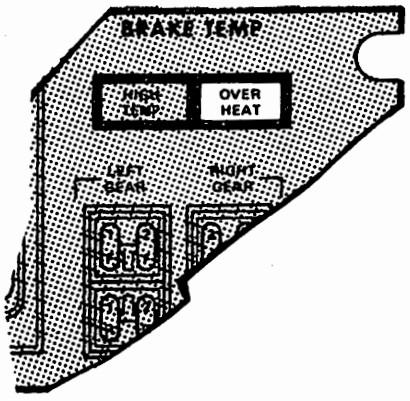
OVERHEAT LAMP
(Red)

Associated amber MWS

Control is identical to the High Temperature Lamp.

The lamp illuminates when the brake temperature exceeds 400°C.

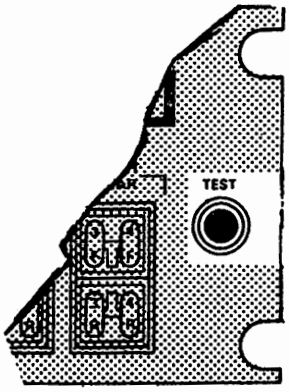
(The HIGH TEMP lamp would also be illuminated)

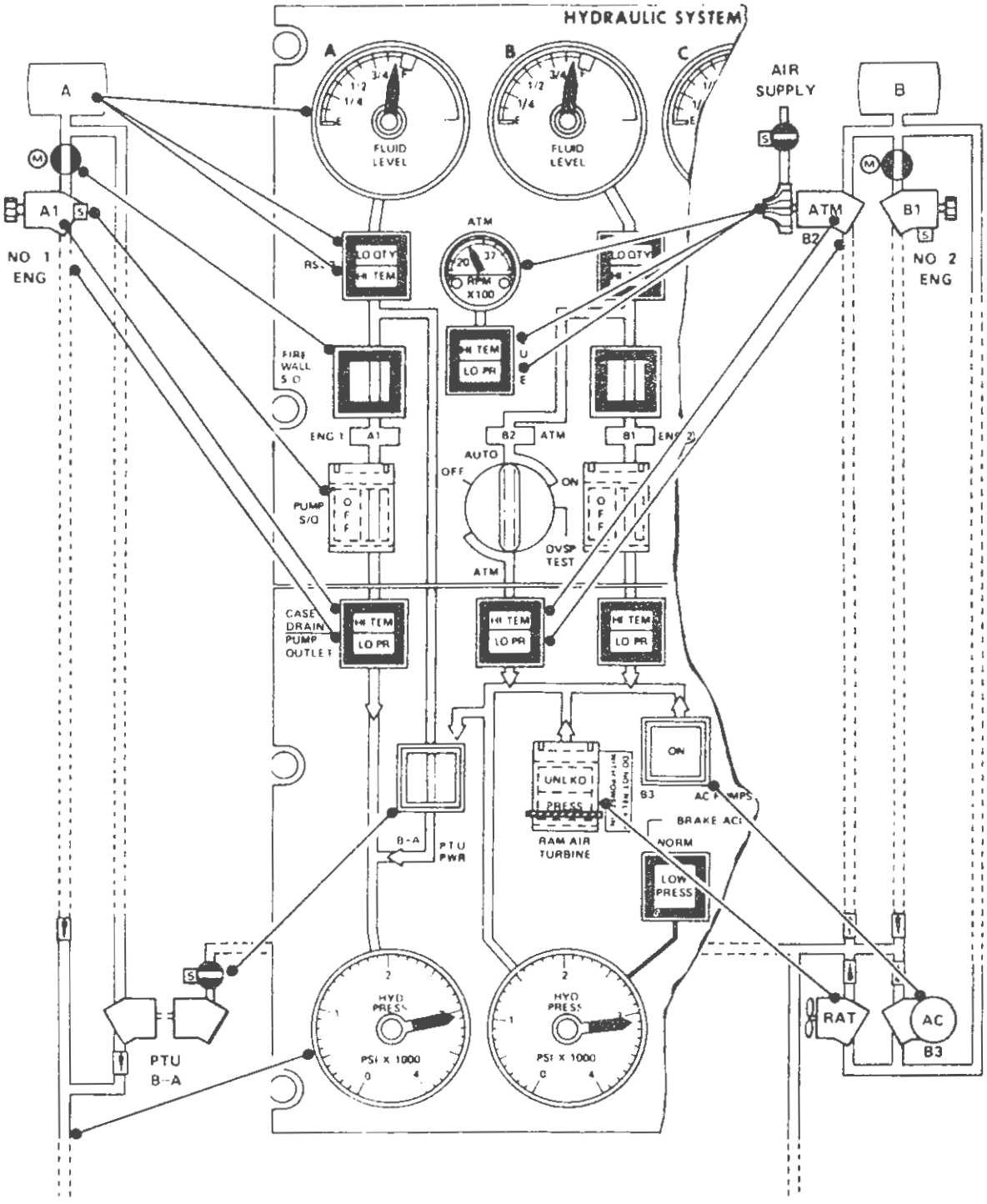


TEST SWITCH

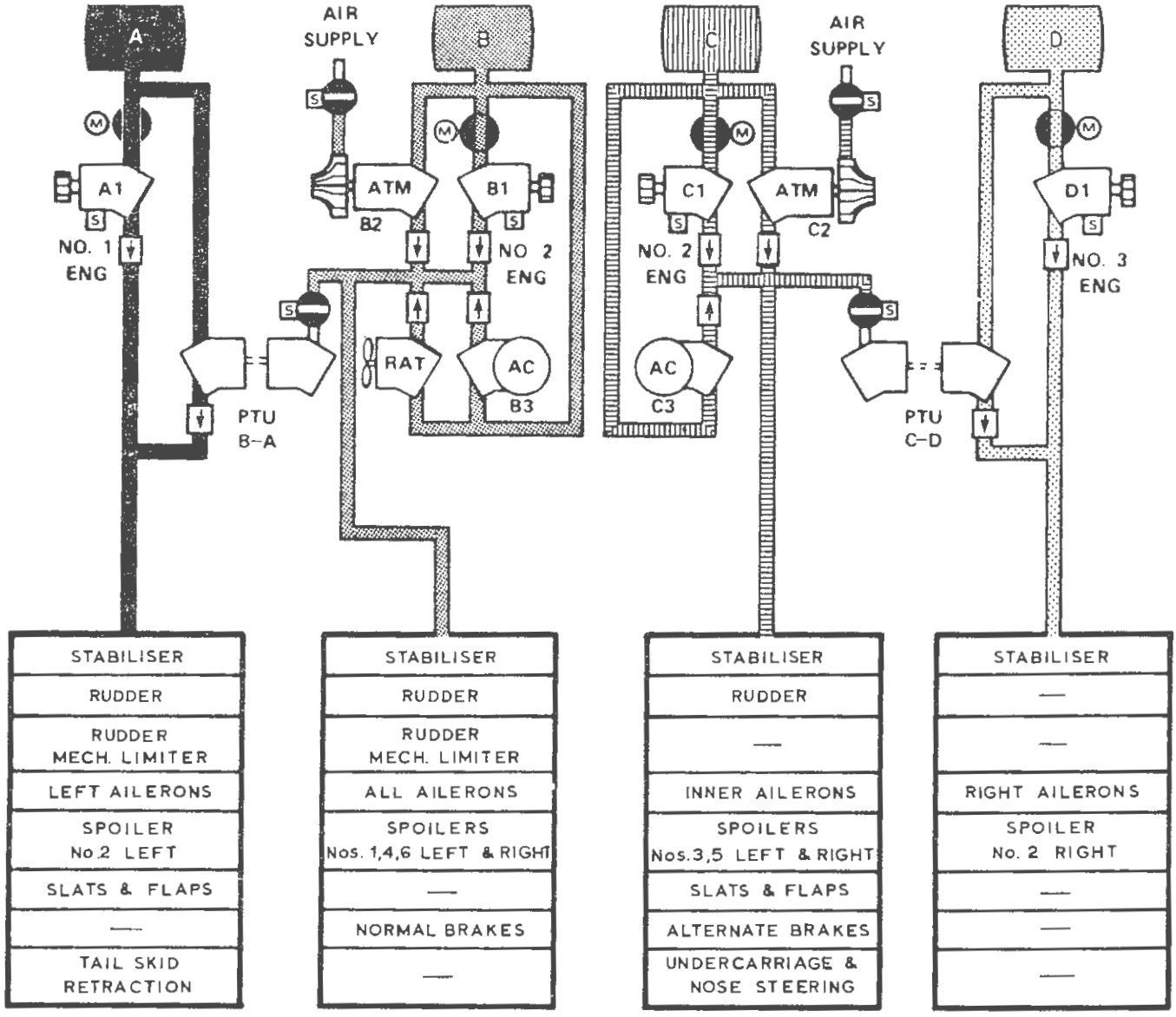
When pressed, the temperature of the selected brakes will be raised by 100°C.

The HIGH TEMP and OVERHEAT and MWS lamps will illuminate if the indicated temperature goes into the appropriate range.

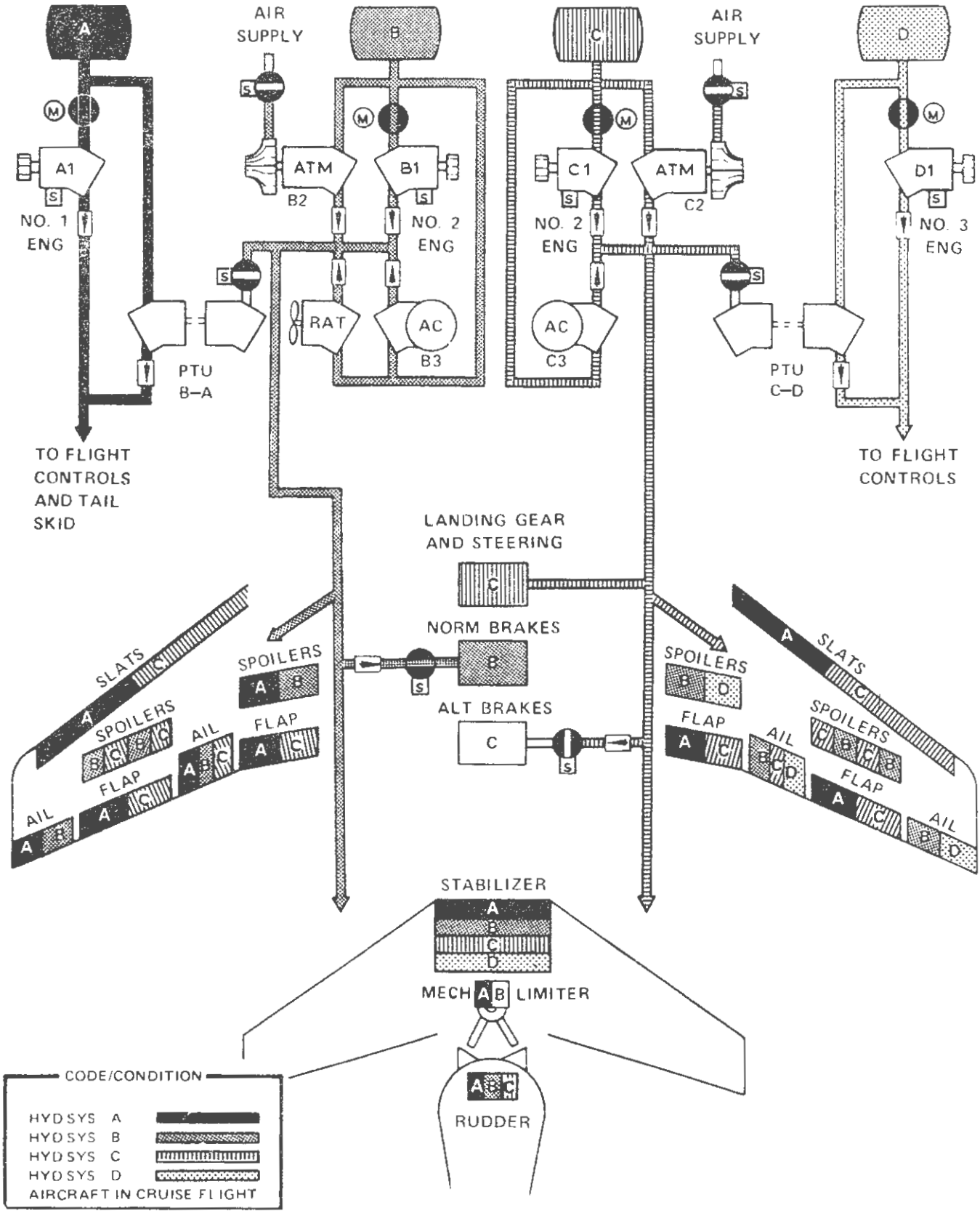




HYDRAULIC SYSTEM CONTROLS AND INDICATIONS



HYDRAULIC SYSTEM AND SERVICES



HYDRAULIC SYSTEM AND DISTRIBUTION

FLYING CONTROLS

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PRIMARY FLIGHT CONTROLS

INTRODUCTION

The flight controls are quite conventional, consisting of hydraulically powered ailerons, rudder and stabiliser.

Under certain flight conditions, wing spoilers assist in pitch and roll control.

Control column, aileron handwheel, rudder pedal and trim selectors are conventional in shape, location and operation. Flight deck demands are mechanically transmitted to the hydraulic selectors.

The aileron and stabiliser control runs are duplicated and are fitted with the facility to disconnect the Captain's from the right-hand Pilot's system.

Flight deck indication is provided of flight control position, also control and indication is provided for the flight - control - electronic - systems.

STABILISER

DESCRIPTION

The aircraft is fitted with a one-piece stabiliser and geared elevator.

The stabiliser is moved from -1° to $+14^{\circ}$, the elevator being automatically moved by a mechanical linkage.

Stabiliser movement is achieved by two pairs of hydraulic jacks, each jack being supplied by a separate hydraulic system.

Each pair of jacks is controlled by a pair of hydraulic servos, the servos being operated by inputs from the control columns, trim selections or auto-pilot demands.

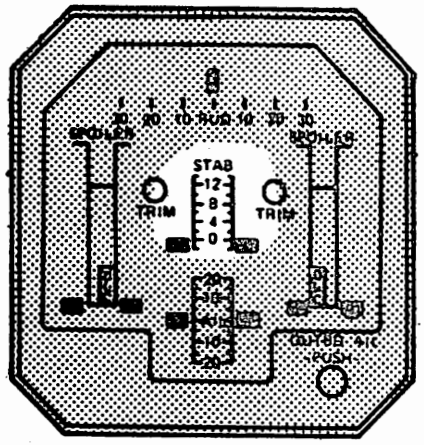
Normally the two runs are connected and inputs from any source will move both pairs of servos, which supply the four jacks, to move the stabiliser.

Stabiliser movement is indicated on the surface position indicator.

STABILISER POSITION INDICATOR.
(Left-hand instrument panel)

Control column authority
-1^{0} to $+14^{0}$

Trim authority
0^{0} to $+10^{0}$



FEEL

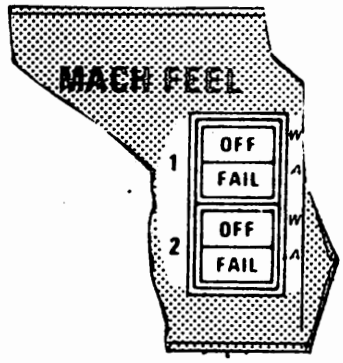
Two forms of feel are fitted, spring feel and Mach feel.

There is no indication or control of spring feel, however, control and indication is provided for Mach feel.

MACH FEEL SWITCHES

Associated MWS (with FAIL)

FLT CONT PANELS A



Normal position — Latched IN

Normal indication — Extinguished

Normal operation

Latched IN — Feel is introduced proportional to Mach number

The Mach feel channels are self monitored for serviceability.

Latched OUT — The channel is switched off. OFF is illuminated.

Abnormal Operation — If a fault occurs the channel is automatically de-activated, FAIL and MWS is illuminated.

When the affected channel is selected OFF, FAIL will extinguish.

Certain faults in a single channel will cause both channels to be de-activated. The defective channel can be identified by the abnormal procedure.

A single channel will provide normal system operation. With both channels off, the feel force will remain as it was at the time of the failure.

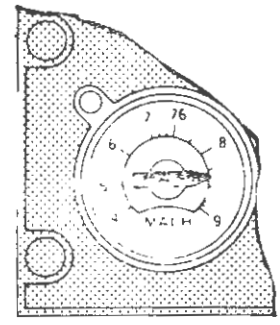
MACH FEEL INDICATOR

Operation

The feel introduced into the control system is indicated by the pointer.

Normally this will agree with the aircraft Mach number.

With electric power off, the pointer indicates M.0.73 (12 O'Clock)



TRIM

The stabiliser may be trimmed by:-

i. Pitch trim handwheels
ii. Electric power trim selectors
iii. Auto pilot trim
iv. Automatic Mach Trim

Each system re-datums the mechanical feel spring.

PITCH TRIM HANDWHEELS (Each side of pedestal)

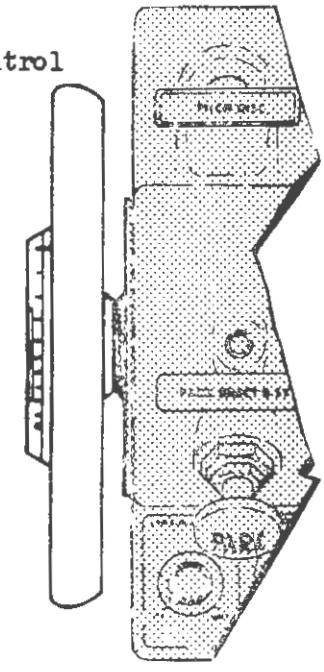
These provide manual mechanical control of pitch trim and override of electrical trim.

The indicator shows the position of the stabiliser in degrees.

Trim authority is from 0° to 10°

The column moves half the normal range as trim is applied.

A take-off warning is introduced if an attempt is made to take off with the trim outside the normal take off range. ($2\frac{1}{2}^{\circ}$ to 8°).



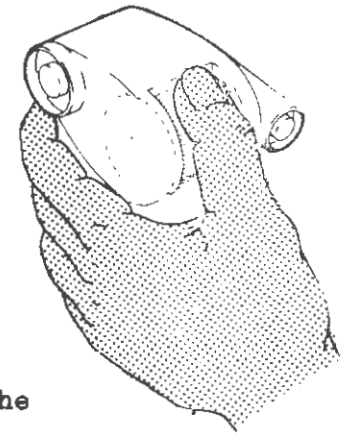
ELECTRICAL POWER TRIM THUMBWHEEL (P1 and P2 columns)

Rotating the thumbwheel provides electrical power to two trim motors.

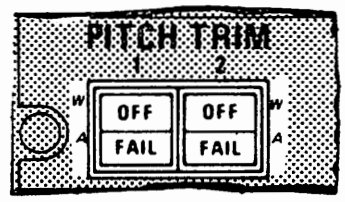
Forward rotation causes nose down. Aft rotation causes nose up.

As power trim is applied, the manual trim wheel and control column respond.

The power trim is controlled by the pitch trim switches.



PITCH TRIM SWITCHES



Associated MWS (with FAIL)

Normal position Latched IN

Normal indication Extinguished

Normal operation

Latched IN - The pitch trim motors will respond to signals from the Power Trim thumbwheel and/or auto pilot.

The pitch trim channels are self monitored for serviceability.

Latched OUT -The channel is switched off.

OFF is illuminated.

Abnormal Operation

If a fault occurs the channel is automatically de-activated. FAIL and MWS are illuminated.

When the affected channel is selected OFF, FAIL will extinguish.

A single channel will provide electric trim over the normal range but at **half** rate.

With both channels off, mechanical trim remains effective.

Auto-pilot Trim

When the autopilot is engaged in any mode, the aircraft is automatically trimmed in pitch via the electric trim system.

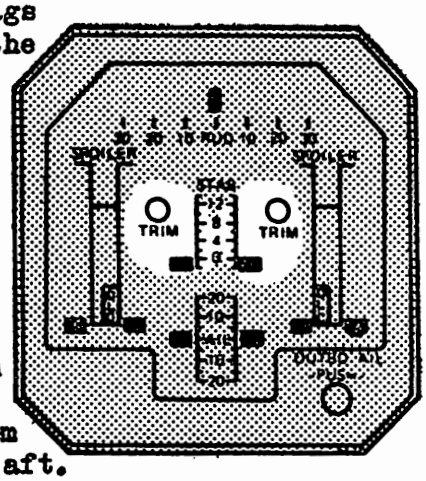
While autopilot trim is being applied, the pitch trim handwheels and column respond.

Any difference between the mechanical pitch trim demand and the autopilot pitch trim demand is indicated by yellow warning flags on the surface position indicator.

(During an automatic approach/land these flags may appear. See A.F.C.S. notes).

Stabiliser Auto-Trim Warning Flag

With autopilot engaged, the flags indicate a difference between the mechanical and autopilot trim demands.



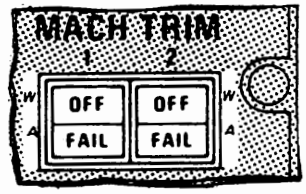
Mach Trim

To compensate for the nose down tendency as speed is increased above 0.76, the Mach trim system automatically moves the column aft.

The mach trim system is controlled by the Mach trim switches.

MACH TRIM SWITCHES

Associated MWS (With FAIL)



Normal Position Latched IN.

Normal Indication Extinguished.

Normal Operation

Latched IN - As the Mach Number varies, corrective trim is applied. The trim handwheel and column move as the trim changes.

The mach trim channels are self monitored for serviceability.

Latched OUT- The channel is switched off.

OFF is illuminated.

Abnormal Operation If a fault occurs, the channel is automatically de-activated. FAIL and MWS are illuminated.

When the affected channel is selected OFF, FAIL will extinguish.

A Single channel will provide normal system operation.

PITCH MONITORS

Sensors are fitted to the duplicated control runs to detect control run failures.

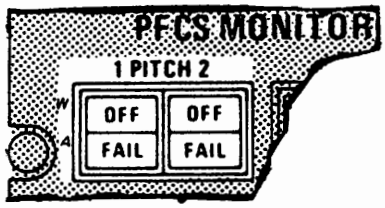
The sensors are connected to two pitch monitors which provide the flight deck warning.

The two monitors are themselves "monitored" and warning is given of monitor failure.

PITCH MONITOR SWITCHES

Associated MWS (With FAIL)

FLT CONT A PANELS



Normal position Latched IN

Normal indication Extinguished

Normal Operation

Latched IN - The control runs are monitored for breakage and seizure. If a defect occurs, the appropriate warning is given (see stabilizer switch light description).

The monitor channels are self monitored for serviceability.

Latched OUT - The channel is switched OFF.

OFF is illuminated.

Abnormal Operation

If a fault occurs within a channel, it is automatically de-activated - FAIL and the MWS are illuminated.

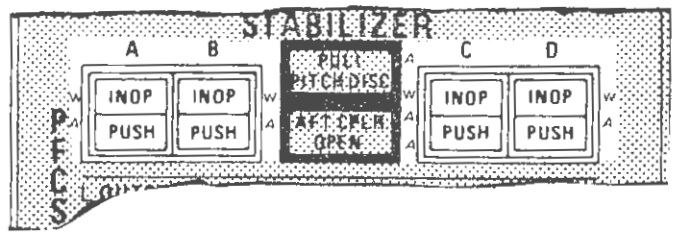
When the affected channel is switched off, FAIL will extinguish.

A single channel will provide full pitch monitoring.

Note that with <u>BOTH</u> monitors switched off, stabilizer control is not affected, only the control run defect warning.

STABILISER CONTROL SWITCHES AND LAMPS

Associated MWS (With PUSH /INOP)



Normal Position — **Latched IN.**

Normal Indication — **Extinguished.**

Normal Operation

Latched IN – **The appropriate hydraulic control servos are pressurised by their hydraulic system and will respond to stabiliser control inputs.**

Whenever a hydraulic system is depressurised, the appropriate white INOP lamp, and the MWS are illuminated.

Latched OUT – The control servos are depressurised. INOP and the MWS are illuminated.

A mechanical interlock prevents all servos being depressurised while any hydraulic system is pressurised. This interlock is biased towards A & B since B system is backed by the R.A.T.

Abnormal Operation

Following a control run defect, a pair of PUSH lamps and the MWS will be illuminated. (See Abnormal Description).

If there is an opposing input between the left and right pairs of servos, a detector identifies the defective pair and depressurises them.
This is indicated by a pair of INOP lamps, with the switches latched in and normal hydraulic pressure.

AFT CPLR OPEN LAMP

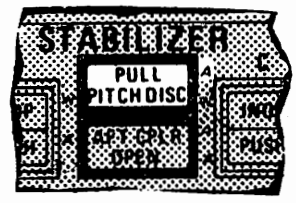
Associated MWS

Normal Indication — Extinguished

Abnormal Indication — The lamp is illuminated to indicate that the aft coupler has automatically opened.

This will occur whenever a pair of switchlights is latched out.

PULL PITCH DISC LAMP



Associated MWS

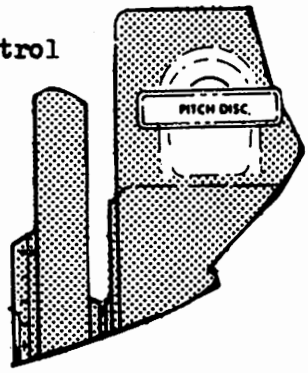
Normal Indication — Extinguished

Abnormal Indication — The lamp is illuminated when the aft coupler has opened <u>following a fault detection</u>.

It is a command to manually disconnect the pitch control system

PITCH DISCONNECT HANDLE (L.H.Side of pedestal)

It mechanically disconnects the control columns from each other. Rotating 90 degrees locks the handle in the disconnected position. It can be reconnected in flight after synchronizing the control columns. PITCH DISC legend in the handle is illuminated when pulled.



Abnormal Description

If a jam occurs in one control run (for example, the left-hand) no inputs will be transmitted to the left hydraulic servos.

The control run input will be absorbed by an override spring strut.

The column will not be locked, but greater than normal effort will be required to move the column against the spring strut loading.

Column movement will be transmitted to the right servos, the right jacks will operate moving the stabiliser. (A relief valve in the left servos allowing fluid to be displaced from the left jacks).

The operation of the override spring strut is detected by both pitch monitors which then illuminate the stabiliser A and B PUSH lamps and the MWS.

Note that the pitch monitors merely <u>indicate</u> a defect, no automatic corrective action is taken.

When the PUSH lamps are pressed, the A and B servos are de-pressurised PUSH is extinguished and INOP is illuminated. The MWS will remain illuminated and must be cancelled.

When the A and B switchlights are latched out the aft coupler is automatically opened.

As it opens, the AFT CPLR OPEN lamp and the PULL PITCH DISC lamp illuminate.

The two control runs should be disconnected at the front by pulling the pitch disconnect handle.

The defective control run is therefore disconnected forward and aft and the ineffective jacks are depressurised.

Having disconnected the control runs, the effect of the pitch trim, feel and autopilot systems is likely to be affected, to a greater or lesser degree, depending upon the side, location and type of control defect.

RUDDER

INTRODUCTION

The rudder is hydraulically moved by a triple hydraulic jack arrangement, system A, B and C supplying separate jack assemblies.

The interconnected pedals are connected by a single control run to the hydraulic selectors.

The rudder is fitted with a conventional trim system. A yaw Stability Augmentation System is also fitted. (Yaw S.A.S.). Following rudder abnormalities, the jacks can be depressurised and the rudder will stream neutral.

Automatic hydraulic and mechanical rudder travel limiters are introduced at appropriate flap and speed settings.

Rudder demands are made by:

1. Rudder pedal movement
2. Rudder trim selections.
3. Yaws Stability Augmentation System (S.A.S.)
4. Auto pilot demands.

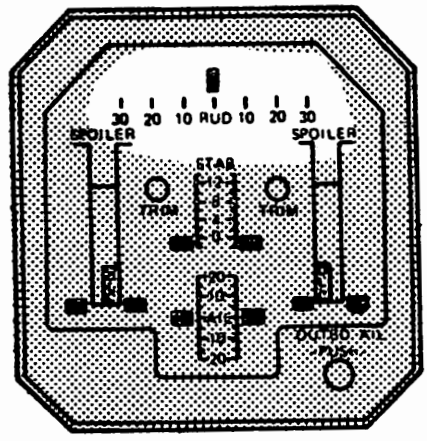
RUDDER FUSING

This prevents a hydraulic pipe failure in the rear fuselage causing a complete loss of system A.

CONTROLS & INDICATORS

RUDDER POSITION INDICATOR

Rudder pedal Authority	Max	$\pm$ 30°
	Limited	$\pm$ 8°
Trim Authority	Max	$\pm$ 10°
	Limited	$\pm$ 8°
Yaw S.A.S. Authority	Normal Max	$\pm$ 10°
	Normal Limited	$\pm$ 8°
	Autoland	$\pm$ 30°



FEEL

Only Spring feel is introduced into the rudder system.

TRIM

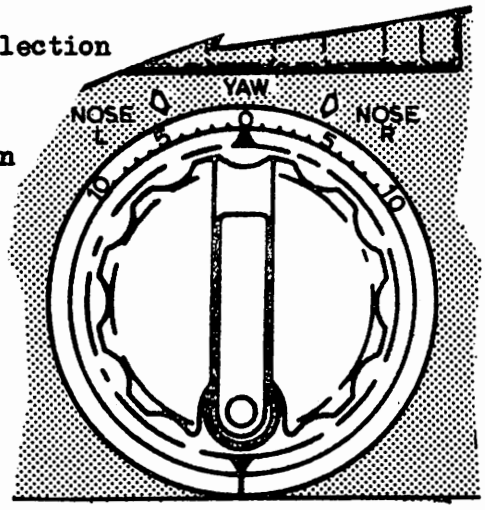
The application of trim re-datums the spring feel system which deflects both the rudder and the pedals.

YAW TRIM SELECTOR

This provides mechanical selection of rudder trim.

Applied trim is indicated on the outer scale.

A handle can be unfolded if required.



Yaw Stability Augmention System S.A.S.

This provides turn co-ordination and yaw damping. Yaw S.A.S. demands may or may not cause rudder pedal deflection, depending upon autopilot mode and flap position (also, the yaw SAS authority varies according to autopilot mode. See A.F.C.S. notes).

RUDDER CONTROL ABNORMALITIES

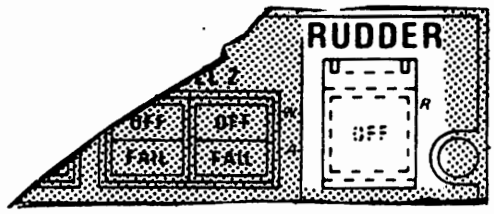
No electrical warning of rudder abnormality is given.

If rudder behaviour is unusual and a defect is suspected, the hydraulic jacks can be depressurised, allowing the rudder to stream neutral.

This is achieved by unlatching the Rudder power switch.

RUDDER POWER SWITCH

Associated MWS (with OFF)	FLT CONT PANELS A
Normal Position	Latched IN
Normal Indication	Extinguished



Normal Operation

With the switch latched IN, and hydraulic pressure available, the rudder will respond to control demands.

Abnormal Operation

If the switch is latched OUT, the RED OFF lamp and the AMBER MWS are illuminated.

All hydraulic supplies to the rudder are shut off, the jacks depressurised and the rudder will stream to the neutral position.

RUDDER LIMITERS

Hydraulic Limiter

As IAS is increased, rudder movement is automatically limited by reducing the available hydraulic pressure to the jacks.

At 164K and below, systems A, B and C, at 3000 P.S.I. are available.

Between 164 and 260 K, systems A and B are shutdown leaving C at 3000 P.S.I.

Above 260K, system C pressure to the rudder jack is reduced to 2000 PSI (C main system pressure remains at 3000 PSI).

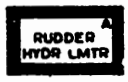
If C pressure is off-loaded, A system (at 3000 PSI) automatically replaces it.

The hydraulic limiter is controlled by the limiter switch.

HYDRAULIC LIMITER SWITCH

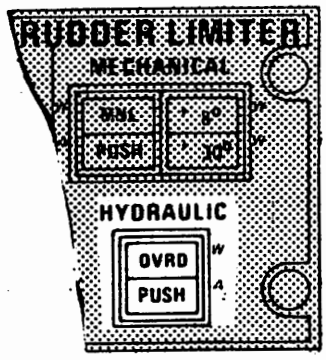
Associated MWS

With PUSH

With incorrect hydraulic distribution for flight condition 

Normal Position

Latched IN



Normal Indication

Extinguished

Normal Operation

The hydraulic distribution to the rudder varies according to the flight condition.

Abnormal Operation

PUSH is illuminated under the following conditions:

a) A, B or C system not available at the rudder with speed less than 164K (Flaps DOWN only)

b) A and C system not available at the rudder with speed greater than 164K (Flaps UP or DOWN)

When the switch is latched out, all available hydraulic pressure is restored to the rudder.

PUSH is extinguished and OVRD is illuminated.

NOTE that PUSH is illuminated only for the inadequate pressure. Excessive pressure is indicated only by the MWS RUDDER HYDR LMTR.

Mechanical Limiter

The normal range of movement of $\pm 30^{\circ}$ is limited to $+ 8^{\circ}$ by travel stops operated by hydraulic systems A and B. Either hydraulic system will provide limiter operation. The limiter is automatically introduced when the flaps are UP and the speed exceeds 164K. The limiters are removed when the flaps leave the UP position or the speed is below 164K.

Automatic operation can be de-activated, and the rudder range controlled directly, by the mechanical limiter switches.

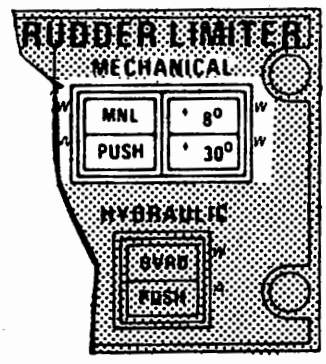
MECHANICAL LIMITER SWITCHES

Associated MWS

With PUSH [FLT CONT A PANELS]

With incorrect range for flight condition. [RUDDER A MECH LMTR]

PUSH/MNL SWITCH



Normal Position

Latched IN

Normal Indication

Extinguished

Normal Operation

The travel is limited to 8° or 30° according to the flap and speed settings.

$8^{\circ}/30^{\circ}$ Switch

Normal Position

Latched IN.

Normal Indication

8° or 30° depending upon speed and flap settings.

(Flap UP, exceeding 164K - 8°
Flap DOWN, less than 164K - 30°)

With the MNL/PUSH lamp latched in, (all lights extinguished) the 8/30 switch acts purely as an indicator.

With the MNL/PUSH lamp latched out, (MNL illuminated) the 8/30 switch acts as a selector/indicator.

Mechanical Limiter Abnormal Operation

If the mechanical limiter is in the wrong position for the speed/flap settings, both MWS displays and the PUSH lamp will be illuminated.

When the PUSH lamp is pressed (Latched OUT) the PUSH will be extinguished, and the white MNL lamp will illuminate.

This indicates that automatic limiter operation has been inhibited and that it must be controlled manually.

Unlatching the PUSH lamp also changes the mode of the $8^{\circ}/30^{\circ}$ lamp to a selector/indicator.

$8^{\circ}/30^{\circ}$ SWITCH (With PUSH/MNL Unlatched)

Latched IN - $\pm 30^{\circ}$

Latched OUT - $\pm 8^{\circ}$

Having unlatched the PUSH/MNL switch, the correct selection must be made on the $8^{\circ}/30^{\circ}$ switch.

When the mechanical limiters are correctly positioned the MWS RUDDER MECH LMTR will extinguish.

If at any time the limiter is incorrect for the speed and flap settings, the MWS RUDDER MECH LMTR will be illuminated.

AILERONS

INTRODUCTION

Four ailerons are fitted to the aircraft, the inners are powered by three hydraulic jacks, the outers by two jacks. Hydraulic supplies to the jacks are shared between all four systems. system B being common to all four ailerons.

Under certain flight conditions roll control assistance is automatically provided by wing spoilers. (See Spoiler description)

From the handwheels, control runs pass down each side of the fuselage. Under abnormal conditions the runs can be disconnected from each other.

Only spring feel is provided.

Input to aileron system is provided by:-

Handwheel deflection
Auto pilot demand
Trim selection

Aileron control run defects are detected and indicated by two roll monitors.

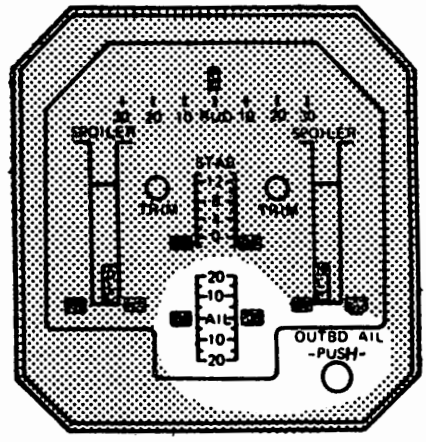
CONTROLS AND INDICATORS

AILERON POSITION INDICATOR (Left instrument panel).

Normally the inner aileron movement is indicated.

Outer aileron position is indicated by pressing the

OUTBD AIL switch

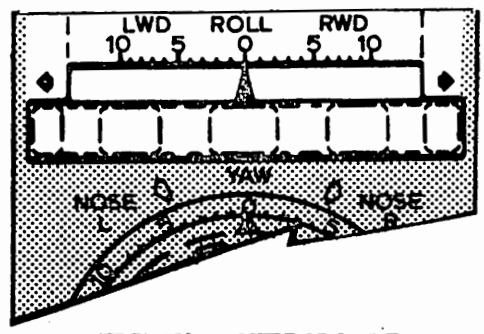


Indicator range $\pm$ 20°
Control range $\pm$ 20°
Trim range $\pm$ 7°

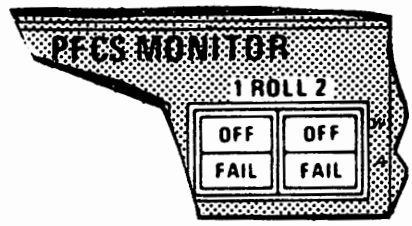
TRIM SELECTOR (Rear of centre pedestal)

Application of aileron trim redatums the spring strut causing aileron and handwheel deflection.

Trim range $\pm$ 7°.



ROLL MONITOR SWITCHES



Associated MWS (with FAIL)

FLT CONT A PANELS

Normal position — Latched IN

Normal indication — Extinguished

Normal Operation

The operation of the roll monitors is identical to the pitch monitors.

Latched IN - If a defect occurs in aileron control run, the appropriate aileron warnings are given. (See aileron switch-light description).

The monitor channels are self monitored for serviceability.

Latched OUT - The channel is switched OFF.

OFF is illuminated.

Abnormal Operation

If a fault occurs within a channel, it is automatically de-activated. FAIL and the MWS are illuminated.

When the affected channel is switched OFF, FAIL will extinguish.

A single channel will provide full roll monitoring.

Note that with <u>BOTH</u> monitors switched off aileron control is not affected, only the control run defect warning.

AILERON CONTROL SWITCHES

Associated MWS (With cross-hatch or OFF) FLT CONT A PANELS

Normal Position Latched IN

Normal Indication Extinguished

Normal Operation

Latched IN - The appropriate hydraulic servos are pressurised by their hydraulic systems and will respond to roll control inputs. (See aileron normal operation).

Latched OUT - The servos are, depressurised OFF and the MWS are illuminated.

Abnormal Operation Following a control run defect, a pair of cross-hatch lamps and the MWS will be illuminated. (See aileron abnormal operation)

PULL ROLL DISC LAMP

Associated MWS FLT CONT A PANELS

Normal Indication Extinguished

Abnormal Indication The lamp is illuminated when the roll monitors detect a fault in the aileron control run.

It will normally be accompanied by a pair of aileron cross-hatch lamps.

Following an aileron control defect the handwheels should be disconnected by operating the roll disconnect handle.

ROLL DISCONNECT HANDLE
(R.H. side of pedestal)

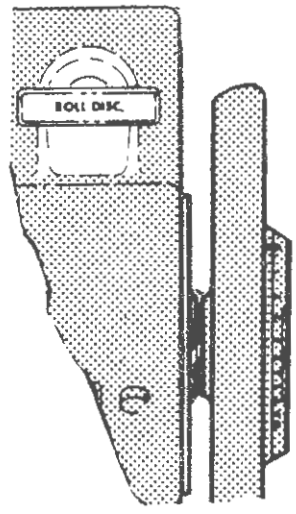
Operation

When pulled, it mechanically disconnects the two aileron control runs and also converts the lost motion device to a direct connection.

Rotating the handle 90° will lock it in the disconnected position.

The two systems can be re-connected in flight after synchronising the handwheels.

ROLL DISC is illuminated when the handle is pulled.



AILERON NORMAL OPERATION

The two aileron handwheels are connected together, movement from either being transmitted, via the left hand control run, to the hydraulic servos of the left hand inner aileron. This aileron is effectively the master aileron of the four. The master aileron is mechanically connected to the hydraulic servos of the left outer and right inner aileron servos.

As the master aileron moves, the left outer and right inner ailerons move.

The right inner aileron is connected to the right outer aileron servo.

Thus, handwheel input causes movement of all four ailerons almost simultaneously.

A feedback is taken from the master aileron via the right hand control run to a "lost motion device" that is connected to the R.H. aileron handwheel.

The purpose of the lost motion device is to ensure that under normal conditions, right hand handwheel inputs are directed through the normal control sequence as described, and will not "short circuit" the system by passing inputs direct to the right hand inner aileron.

Autopilot inputs are made directly into A and B servos of the master aileron. Handwheel response to autopilot demands is made via the feedback mechanism.

AILERON ABNORMAL OPERATION

If a jam occurs in a control run - e.g. the left hand - handwheel inputs will be absorbed by the override spring strut.

Further movement of the handwheels will absorb the 15° "slack" in the lost motion device and control demands will be made to the right-hand inboard aileron servos.

As it moves the R.H. outboard aileron servos will be signalled and the outer aileron will respond.

Roll control will therefore be effected by the R.H. ailerons only (supported by spoilers if applicable).

The operation of the override spring strut is detected by the roll monitors which illuminate.

1. MWS FLT CONT PANELS
2. PULL ROLL DISC lamp
3. L OUTBD and L INBD cross-hatch lamps
4. L 5 and 6 and L and R4 spoiler PUSH lamps. (These spoilers are associated with the defective ailerons).

The spoiler PUSH lamps should be pressed to prevent unscheduled spoiler operation. When pressed the PUSH lamps extinguish and OFF is illuminated. (See spoiler notes).

The handwheels should be disconnected by pulling the roll disconnect handle.

Roll control inputs will now pass directly down the R.H. control run to the R.H. inner servo.

The interconnect spring strut will act as a feel strut.

Auto-pilot and trim inputs to the ailerons will be lost.

Initially, the aileron cross hatch lamps are not touched. This keeps the L.H. aileron jacks pressurised and the L.H. ailerons hydraulically locked.

If excessive aileron control is required to maintain straight and level flight, it indicates that the L.H. ailerons are locked in a deflected position.

Under this condition the cross-hatch lamps should be pressed. The CROSS-HATCH is extinguished and OFF is illuminated.

This de-pressurises the aileron jacks and the L.H. ailerons will float up, to the aerodynamic neutral position.

SPOILERS

INTRODUCTION

The spoilers consist of six panels on each wing, numbered 1-6, inner to outer. Failure of 'B' or 'C' hydraulic systems causes a symetrical loss of spoiler panels. Failure of 'A' system affects No.2 left panel and 'D' system affects No.2 right panel.

The spoilers perform four functions, each function being controlled by aircraft configuration.

1. Speedbrake - Flaps retracted.
   Spoilers 2 to 6.
   Maximum extension 60°.
   By selection.
   Input from speedbrake lever

2. Roll Assistance - Flaps beyond 3°
   Spoilers 2 to 6
   Maximum extension 40°
   Automatic
   Input from upgoing aileron

3. Direct Lift Control (D.L.C.) - Flaps selected beyond 30° and aircraft in the approach configuration.
   Spoiler 1 to 4
   Extension 0° to 16°
   Automatic
   Input from D.L.C. computer

4. Auto Ground Spoilers (A.G.S) - 1 Aircraft on ground and flaps selected and positioned beyond 30° and 2 throttles closed.
   2 Aircraft on ground and 2 throttles in reverse.
   Spoilers 1 to 4
   Extension 60°
   Automatic
   Input from DLC computer.

The automatic operation of DLC and AGS is dependant upon a hydraulic servo which is powered by A and B hydraulic systems. Selection of speedbrake is also made via this hydraulic servo.

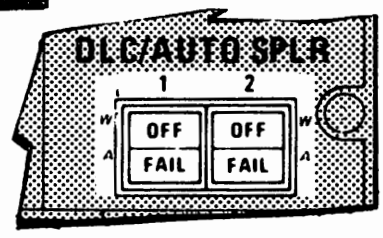
CONTROLS AND INDICATORS

DLC/AUTO SPLR SWITCHES
(FCES Panel)

Associated MWS

With FAIL

With 1 + 2 FAIL and flaps selected to more than 30°.



Normal Position

Latched IN

Normal Indication

Extinguished

Normal Operation

Latched IN - Each channel is switched on and the hydraulic servo will respond to DLC/AGS inputs.

Each channel is self monitored for serviceability.

Latched OUT - The channel is switched off. OFF is illuminated.

Abnormal Operation

If a channel fault occurs it is automatically de-activated, FAIL and the MWS are illuminated.

When switched off, FAIL will extinguish.

With more than 30° flaps, a failure of A hydraulic system will illuminate No.2 FAIL, B hydraulic system No.1 FAIL.

A single channel will provide normal system operation.

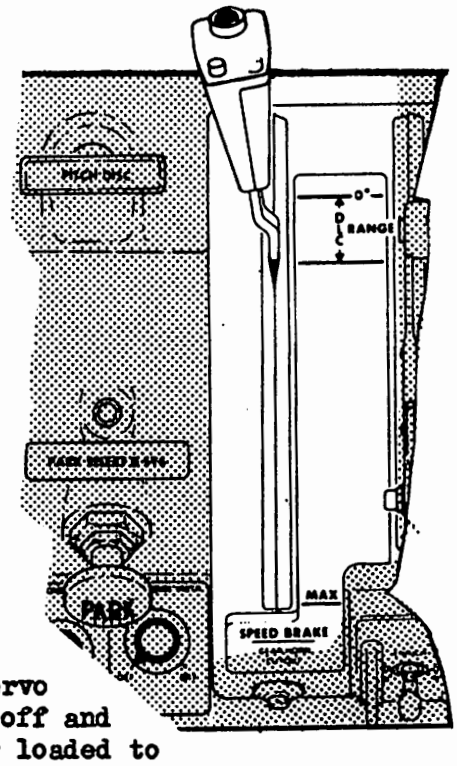
With both channels switch off (and at least A or B hydraulic system pressurised) the servo will still respond to selector lever inputs.

Whenever both channels are switched off (or de-activated) with more than 30° flaps, the MWS AUTO GND SPLRS INOP is illuminated to advise that ground spoilers must be selected manually.

If 'C' system fails, AGS is automatically inhibited to prevent a possible truck tilt introducing AGS in flight.

AGS INOP is illuminated when the landing gear is selected down.

SPEEDBRAKE SELECTOR
(L.H. side of pedestal)



Selector Lever

Selects the airbrake extension (flaps UP) from 0° to 60° by operating the spoiler servo which signals the appropriate spoiler selectors.

During DLC the lever moves within the graduated DLC range ($0 - 16^{\circ}$).

During AGS the lever moves to MAX. (60°).

Disable switch
(On top of the selector lever)

When pressed, the spoiler servo hydraulic supplies are shut off and the selector lever is spring loaded to the 0° position.

Manual selections can be made by pulling the lever against the spring (30lbs). This manually signals the appropriate spoiler selectors.

Both DLC/AUTO SPLR FAIL lamps will illuminate.

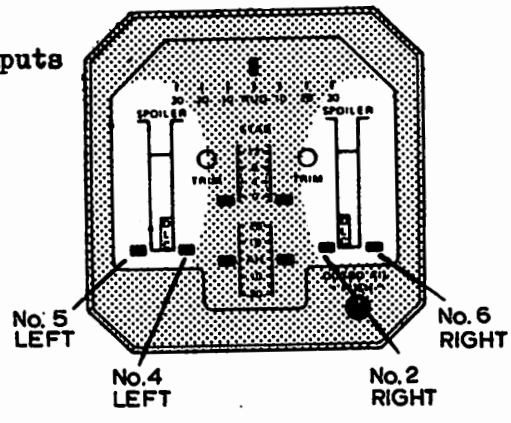
The hydraulic servo can be re-pressurised by re-pressing the disable switch.

The DLC/AUTO SPLR switches must be cycled to re-instate DLC and A.G.S.

SPOILER POSITION INDICATOR

The inner spoilers will respond to all inputs

The outer spoilers will respond to speedbrake and roll augmentation inputs only.



SPOILER CONTROL SWITCHES

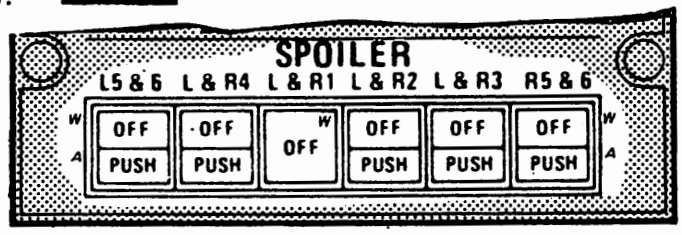
Associated MWS

With PUSH or OFF

With Spoiler 1 to 4 defect.

Normal Position Latched IN

Normal Indication Extinguished



Normal Operation

Latched IN - The appropriate hydraulic control valves are pressurised and the spoilers will respond to all the inputs.

Latched OUT - The control valve is depressurised and the spoiler is locked at 0°.

OFF and MWS FLT CONT PANEL is illuminated.

Abnormal Operation

There are three sets of spoiler abnormalities.

1. An aileron jam affecting spoiler operation.
2. Control faults affecting Nos. 5 and 6 spoilers.
3. Mode changes affecting Nos.1 - 4 spoilers.

Aileron Jam

With flaps down, spoilers 2 to 6 assist in roll control of the aircraft.

If an aileron jams, it is possible that this could lead to unscheduled spoiler operation.

To prevent this, the spoilers that are operated by the defective aileron should be switched off.

These are identified by the illumination of the appropriate spoiler PUSH lamps.

L.H. aileron - L 5 and 6 and L and R 4.
R.H. aileron - R 5 and 6, L and R 3 and L and R 2 and the MWS FLT CONT PANELS.

When the switches are pushed, PUSH is extinguished, OFF is illuminated but the MWS remains illuminated and must be cancelled.

The aileron/spoiler relationship ensures that some spoilers on each wing will be available for roll assistance.

Nos. 5 and 6 Defect

Spoiler operation is controlled by a selector for spoilers 5 and 6 and a mixer for spoilers 1 - 4.

If a defect occurs in a left or right 5 and 6 selector the resulting assymetry when spoilers are selected may lead to aircraft handling difficulties.

To prevent such assymetry, a 5 and 6 selector defect will always illuminate both the L 5 and 6 and R 5 and 6 spoiler PUSH lamps and MWS FLT CONT PANELS.

Again, when the switches are pushed, PUSH is extinguished and OFF is illuminated but the MWS remains illuminated and must be cancelled.

Spoiler action is degraded but assymetric problems are eliminated.

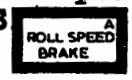
Mode Change Defect

The mode of spoiler operation changes with flap position.

Flaps up. Spoilers 2 - 6. Speedbrake only.

Flaps 3° to 30°. Spoilers 2 - 6 Roll assist only.

Flaps beyond 30°. Spoilers 5 and 6 Roll assist only.
2, 3 and 4 Roll assist and DLC
1 DLC only.

If a defect occurs in the spoiler mixer (controlling 1 - 4) indication is provided by the illumination of the MWS 

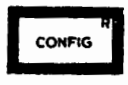
There is NO accompanying system lamp.

The abnormal procedure will determine the defective spoiler.

This rendered inoperative by unlatching the appropriate spoiler control switch.

This will extinguish the MWS ROLL SPEED BRAKE but introduce the MWS FLT CONT PANELS (due to the illumination of the OFF lamp).

SPEEDBRAKE
CONFIGURATION
WARNING

Associated warnings. RED MWS. 

Intermittent horn.

Operation

These warnings are introduced if the speedbrake lever is beyond the DLC range and the flaps are not selected and positioned to 0°.

The configuration must be corrected to silence the horn.

LIFT AUGMENTATION

INTRODUCTION

Lift augmentation is provided by leading edge slats and trailing edge Fowler flaps. The slats consist of seven sections on each wing (the outer four of which are anti-iced).

The flaps consist of four sections per wing. Both the flaps and slats are mechanically operated by hydraulic motors supplied by "A" and "C" systems.

The slats and flaps are monitored and if any asymetry occurs, the entire slat or flap system is locked.

A flap load relieving system (L.R.S.) prevents excessive air loads from damaging the flap system.

LEADING EDGE SLATS

CONTROLS AND INDICATORS

FLAP/SLAT SELECTOR (R.H. Side of pedestal)

Movement of the lever from 0° to 4° fully extends the slats and lowers the flaps to 4°.

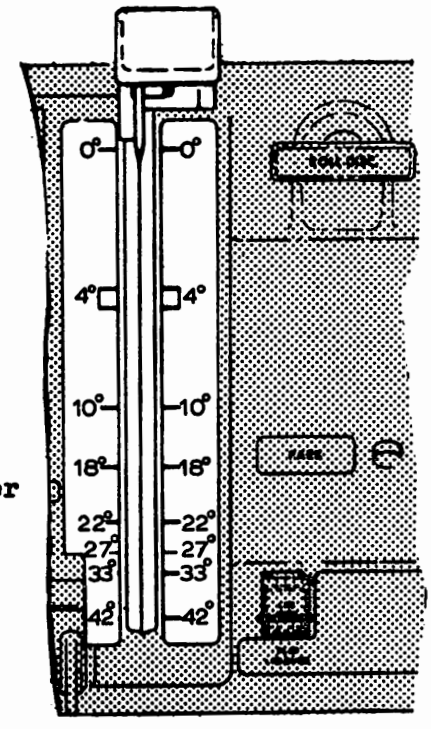
Further movement increases flap extension.

Raising the lever from 4° to 0° retracts the flaps and slats.

The lever is detented at all placarded positions, the lever passing through the detents while the finger latch is lifted.

Baulks are introduced at 4° going up and down 22° going up only.

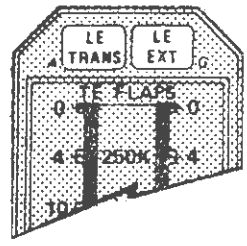
The baulks are passed by releasing the finger latch and re-lifting it.



SLAT POSITION LAMPS
(R.H. Side of centre instrument panel)

LE TRANS
(Amber)

When illuminated it indicates that the slats are not in the selected position.



LE EXT
(Green)

When illuminated, it indicates that all slat sections are fully extended.

SLAT OUT OF POSITION WARNING

Associated MWS (RED) CONFIG

The MWS and an intermittent horn are introduced when:

1. The I.A.S. is below 190K
   and
   The slats are not fully extended
   or
   The selector lever is at 0°.

2. The IAS is above 250K
   and
   The slats are not retracted
   or
   The selector lever is not at 0°

3. On the ground, if any pair of throttles is opened beyond 50% and all slats are not fully extended

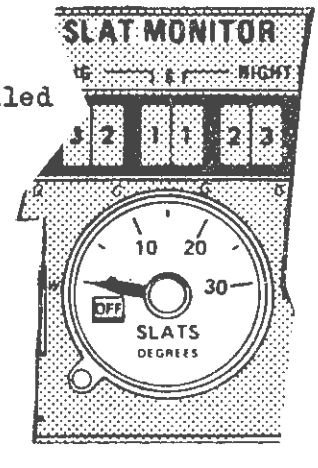
SLAT MONTIOR
(R.H. Upper systems station)

SLAT POSITION INDICATOR

This consists of two pointers labelled L and R, indicating the slat position.

The OFF flag indicates that electrical power is OFF.

This indicator is independent of the monitor switch.

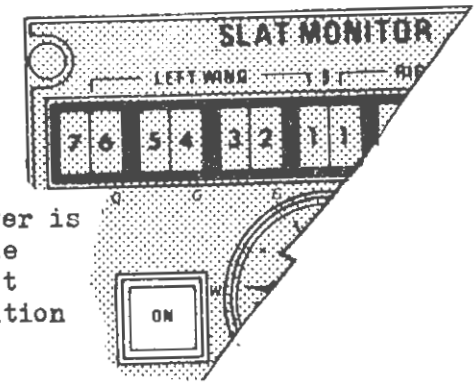


MONITOR SWITCH
(White)

Normal Position — Latched IN

Normal Indication — Illuminated ON

Normal Operation — Latched IN - ON illuminated

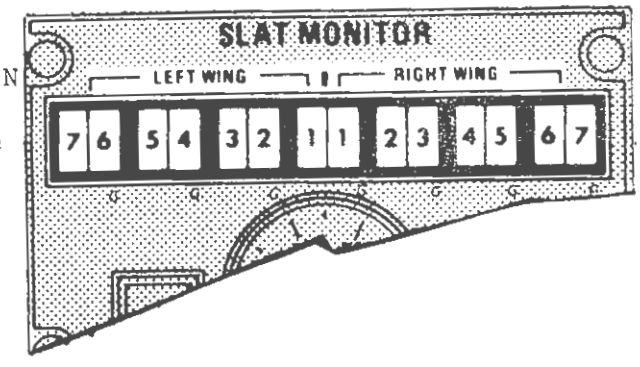


Electrical power is provided to the individual slat section indication system.

Latched OUT - Lamp extinguished.
All slat lamps extinguished.

SLAT SECTION LAMPS
(Green)

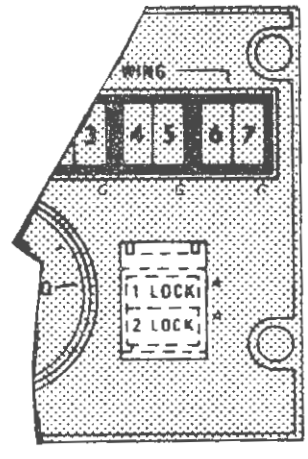
If the monitor switch is latched IN each lamp will illuminate when the associated slat section is fully extended.



LOCK SWITCH
(Amber)

Normal Position — Latched OUT

Normal Indication — Extinguished



Abnormal Operation — A transparent guard must be lifted to operate the switch.

When the switch is latched IN both sets of slats lock in their position.

Lock 1 and Lock 2 lamps are illuminated.

This is mainly a ground servicing switch.

SLAT ABNORMALITIES

Assymetry Detector Fault

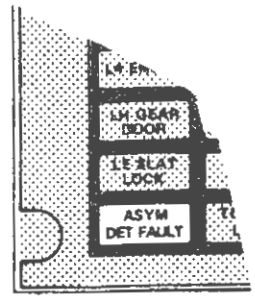
A detector is fitted to detect and control slat and flap asymmetry faults.

The detector is monitored for serviceability and if a fault occurs it is automatically de-activated and a warning is illuminated.

SLAT ASYM DET FAULT WARNING (P3 Annunciator Panel)

When illuminated it indicates a slat and flap asymmetry detector fault.

Slat and flap operation is not affected but asymmetry warning and protection will not be available.



Slat asymmetry

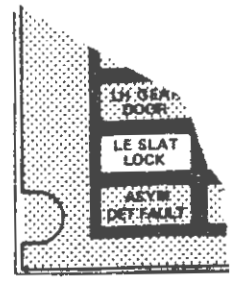
If asymmetry occurs between individual slat sections or between the left and right sections, the fault detector will lock the entire slat assembly in the failed position.

Indication of a slat asymmetry lock is provided by:-

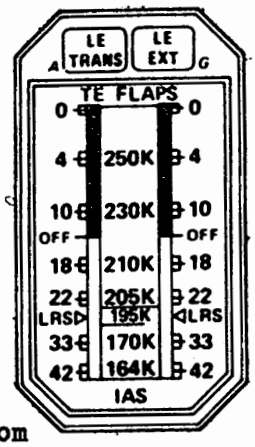
1. Slat LE TRANS lamp
2. Slat position indicator
3. L.E. SLAT LOCK lamp

LE LOCK LAMP (P3 Annuciator Panel)

When illuminated it indicates a slat asymmetry lock.



FLAPS



FLAP POSITION INDICATOR

A moving tape indicator.

With no electrical power, both tapes move to the OFF position.

Flap Load Relieving System (L.R.S.)

This automatically prevents the flaps from responding to extension selections of more than 28° if the IAS exceeds 164 K. If the flaps are extended beyond 28° and the speed is increased above 164 K, they will automatically be retracted to 28°.

Indication that the L.R.S. is limiting flap movement is provided by the MWS display.

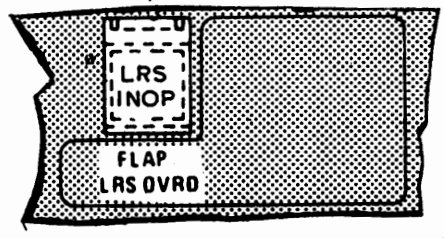
The LRS computer is self monitored for serviceability and if a defect occurs it is automatically de-activated.

Warning is given by the MWS.

(The effect may be to restrict the flap settings to 28° irrespective of IAS, or to fail to raise the flaps if the IAS exceeds 164K).

The LRS can be selected inoperative by an over-ride switch.

LRS OVERRIDE SWITCH (Rear RH of flap selector lever)



Associated MWS (With LRS INOP)

Normal Position — Latched OUT

Normal Indication — Extinguished

Abnormal Operation

With the switch latched IN, the LRS is rendered inoperative and the flaps will respond to flap selections irrespective of I.A.S.

The MWS, FLAP LRS INOP and LRS INOP legend on the switch will be illuminated.

The LRS cannot be re-instated while in flight.

LRS INOP AURAL WARNING

If the LRS is inoperative, a buzzer will sound for 2 seconds whenever the flap selector lever is moved from the 0° position.

Flap Asymmetry

Flap asymmetry is monitored by the combined slat/flap fault detector.

Details of detector faults are given in SLATS ASYM DET FAULT WARNING.

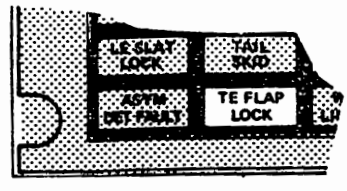
If asymmetry occurs the fault detector will lock the entire flap assembly in the failed position.

Indication of flap asymmetry lock is provided by:-

1. Flap position indicator
2. T.E. FLAP LOCK lamp.

T.E. LOCK LAMP (P3 Annunciator Panel)

When illuminated it indicates a flap asymmetry lock.



Unsafe for take-off warning

The warning consists of:-

i. Intermittent horn
ii. Red MWS CONFIG

It is introduced when:-

i. The aircraft is on the ground
ii. Any pair of throttles are advanced beyond 50% of take-off thrust, and
iii. Flaps not set for take-off, or
iv. Slats not fully extended, or
v. Pitch trim not within the take-off range, or
vi. Speedbrake lever not in 0° position.

The warning cannot be cancelled.

STALL WARNING

INTRODUCTION

With the aircraft in flight, stall warning is provided by duplicated systems which vibrate the control columns. The spoilers are also retracted if they are extended.

The aircraft angle of attack is sensed by alpha probes each side of the aircraft nose.

Warning is introduced at 1.07 Vs at aft C of G to 1.12 Vs at forward C of G.

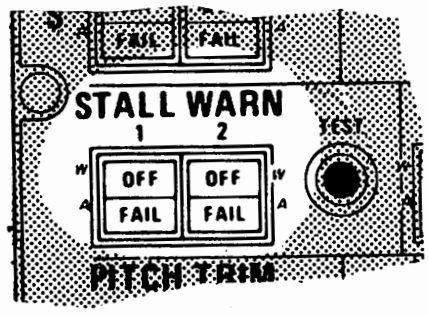
CONTROLS & INDICATORS

STALL WARN SWITCHES

Associated MWS (with FAIL) FLT CONT PANELS A

Normal position - Latched IN

Normal indication- Extinguished



Normal operation

Latched IN Stall warning is provided by No 2 system vibrating the RH column.

Since both columns are interconnected both control columns will vibrate.

Latched OUT The channel is switched off.

Abnormal Operation

If a fault occurs in a channel, FAIL and the MWS are illuminated

No 2 channel must be selected OFF before No 1 channel will provide stall warning.

There is no indication of stick shaker motor failure.

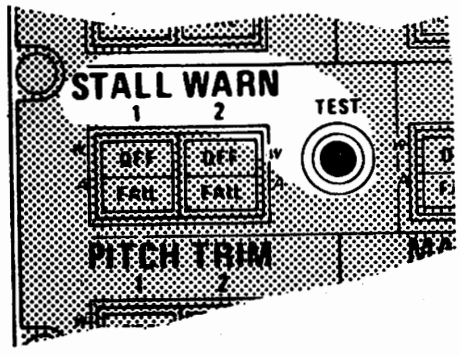
STALL WARNING TEST SWITCH

OPERATION

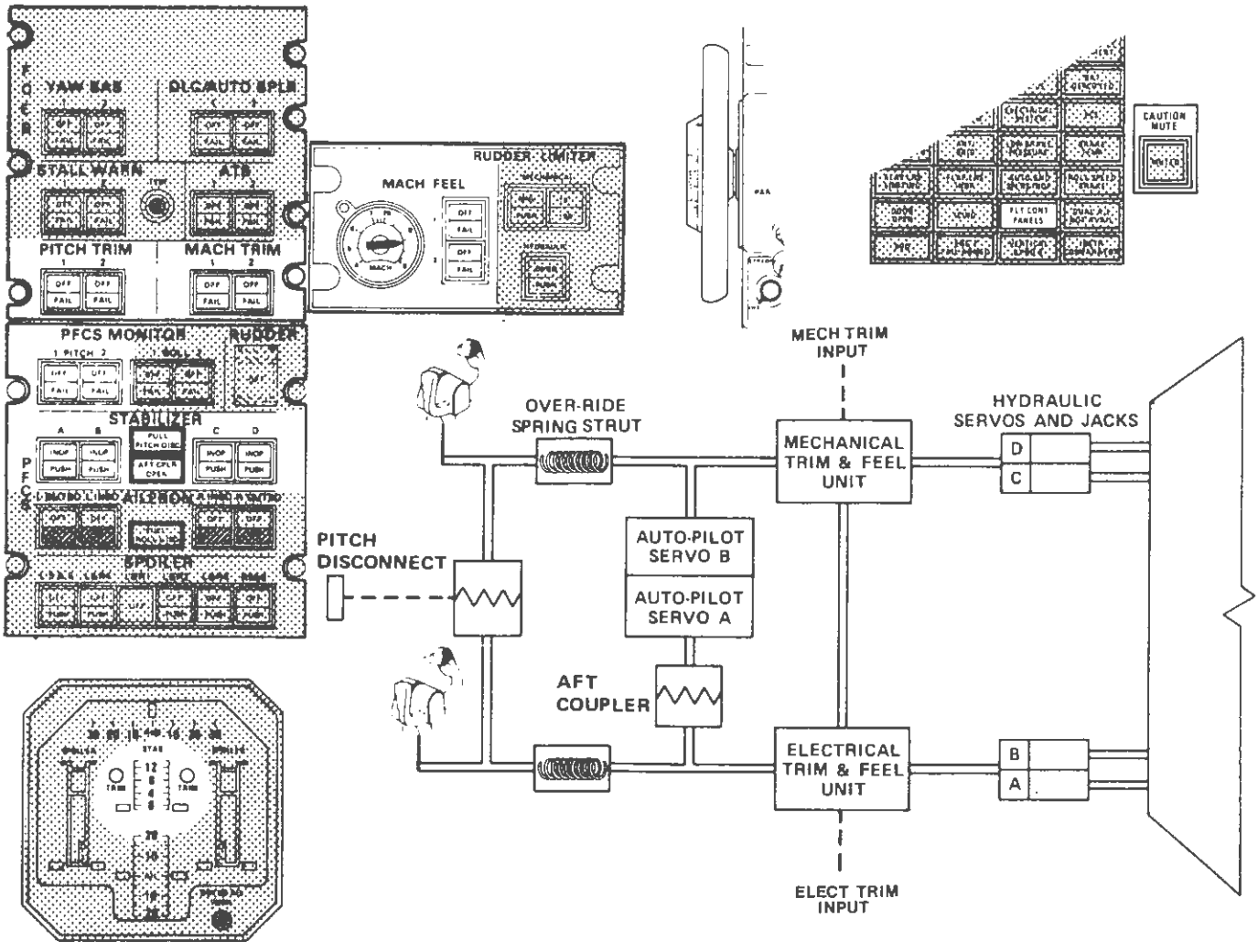
The switch is armed only when the aircraft is on the ground.

When pressed with both switches latched in, No 2 channel and the RH motor only are tested.

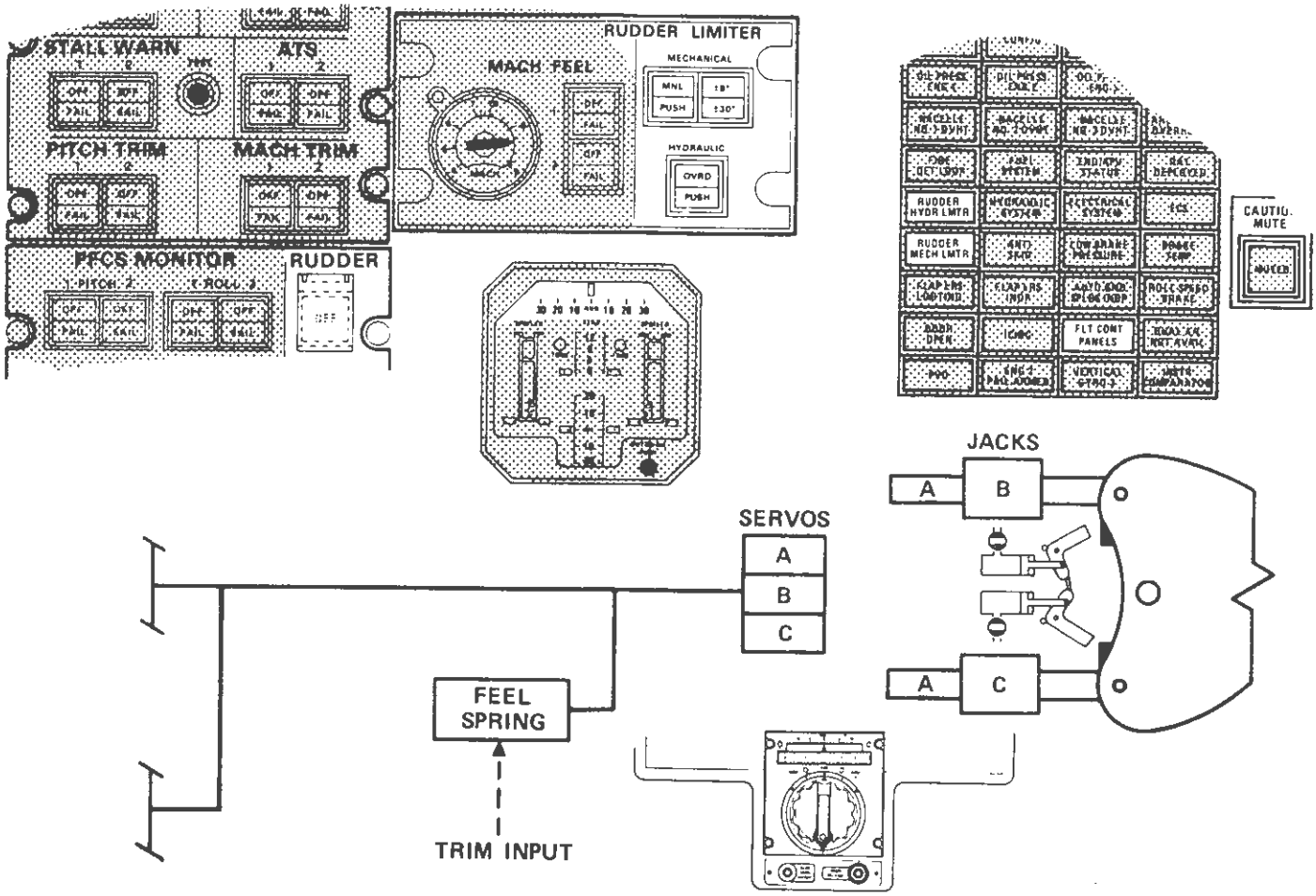
When pressed with a single switch latched in, the selected system is tested.



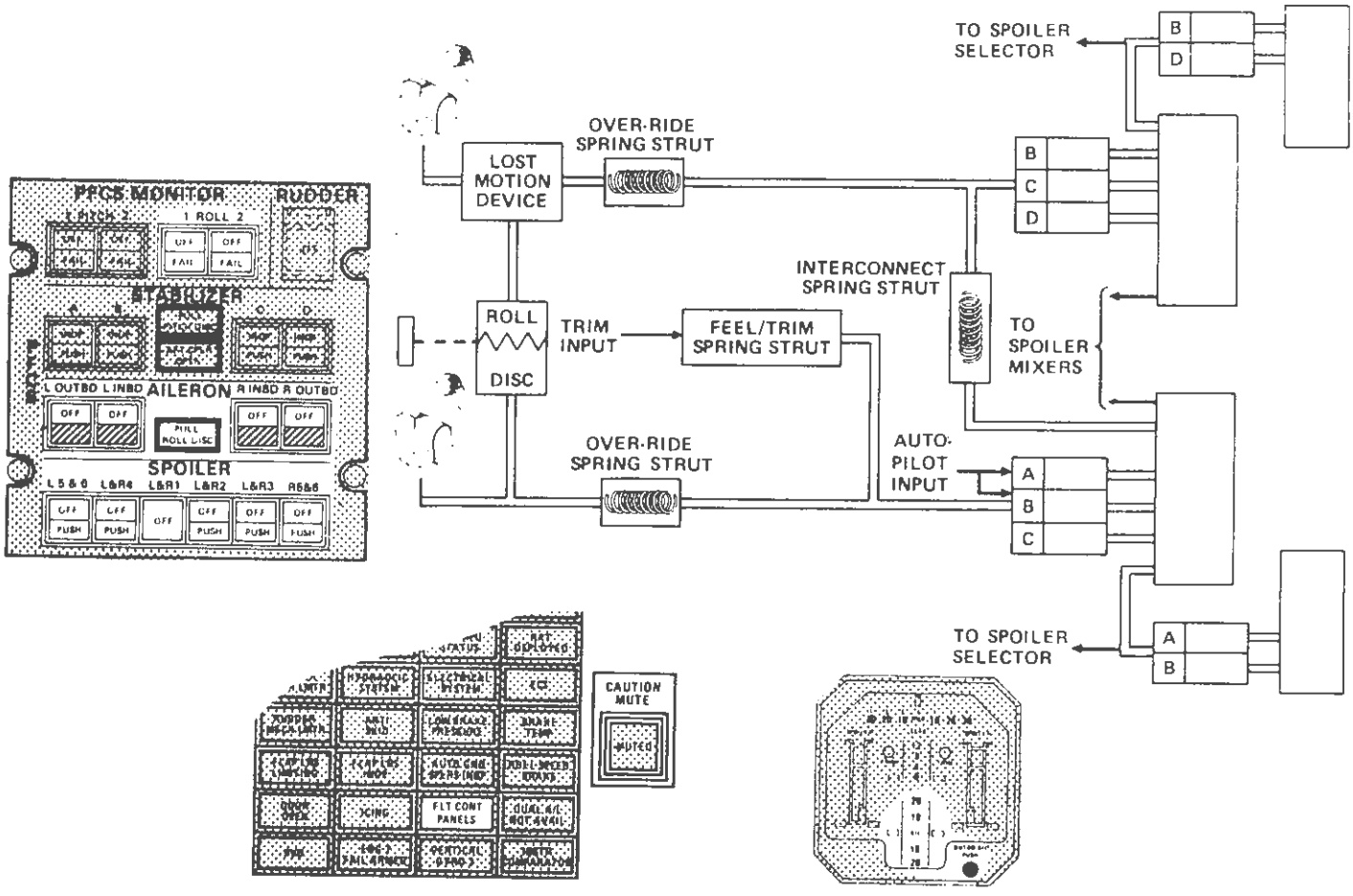
STABILISER SCHEMATIC



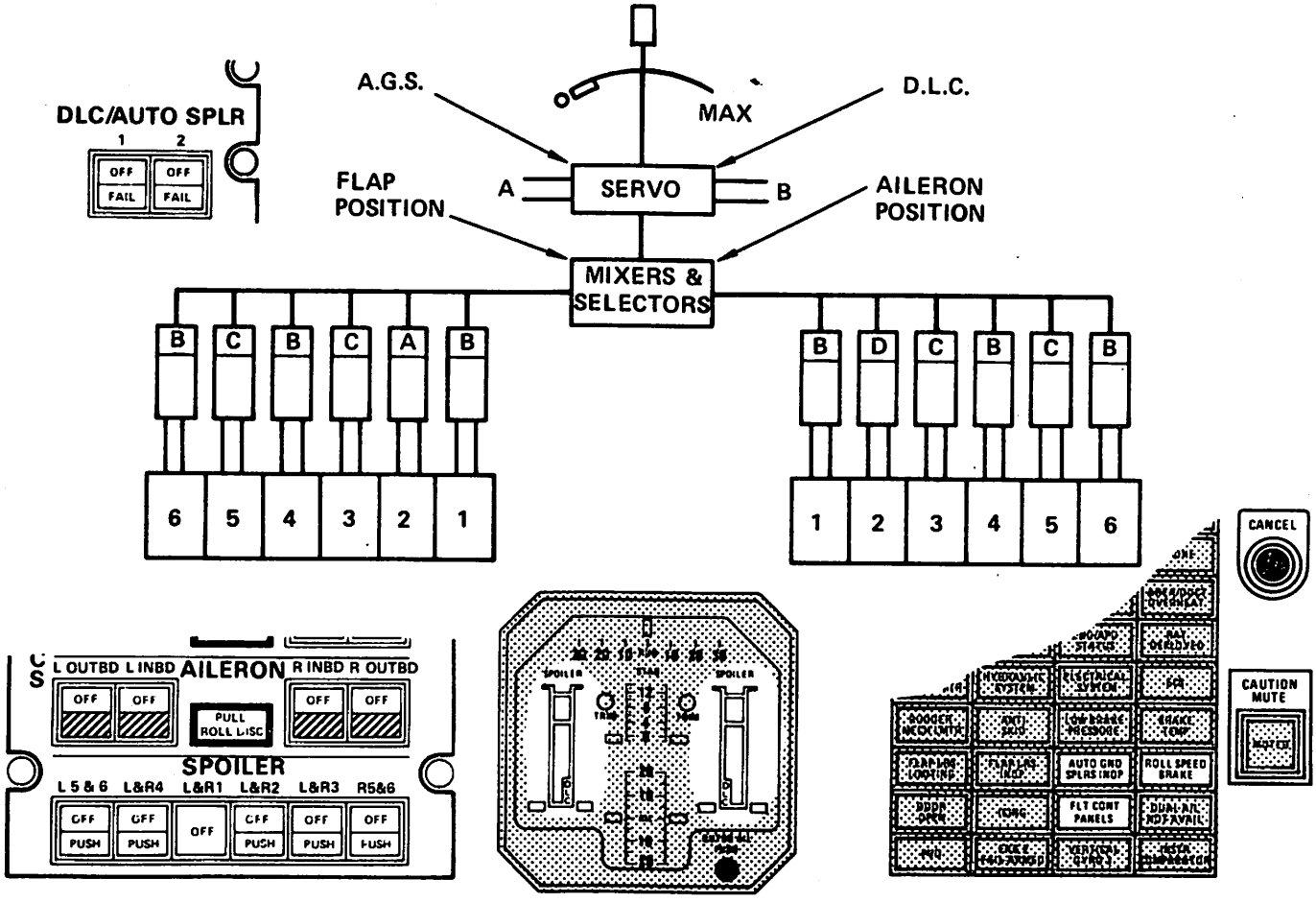
RUDDER SCHEMATIC



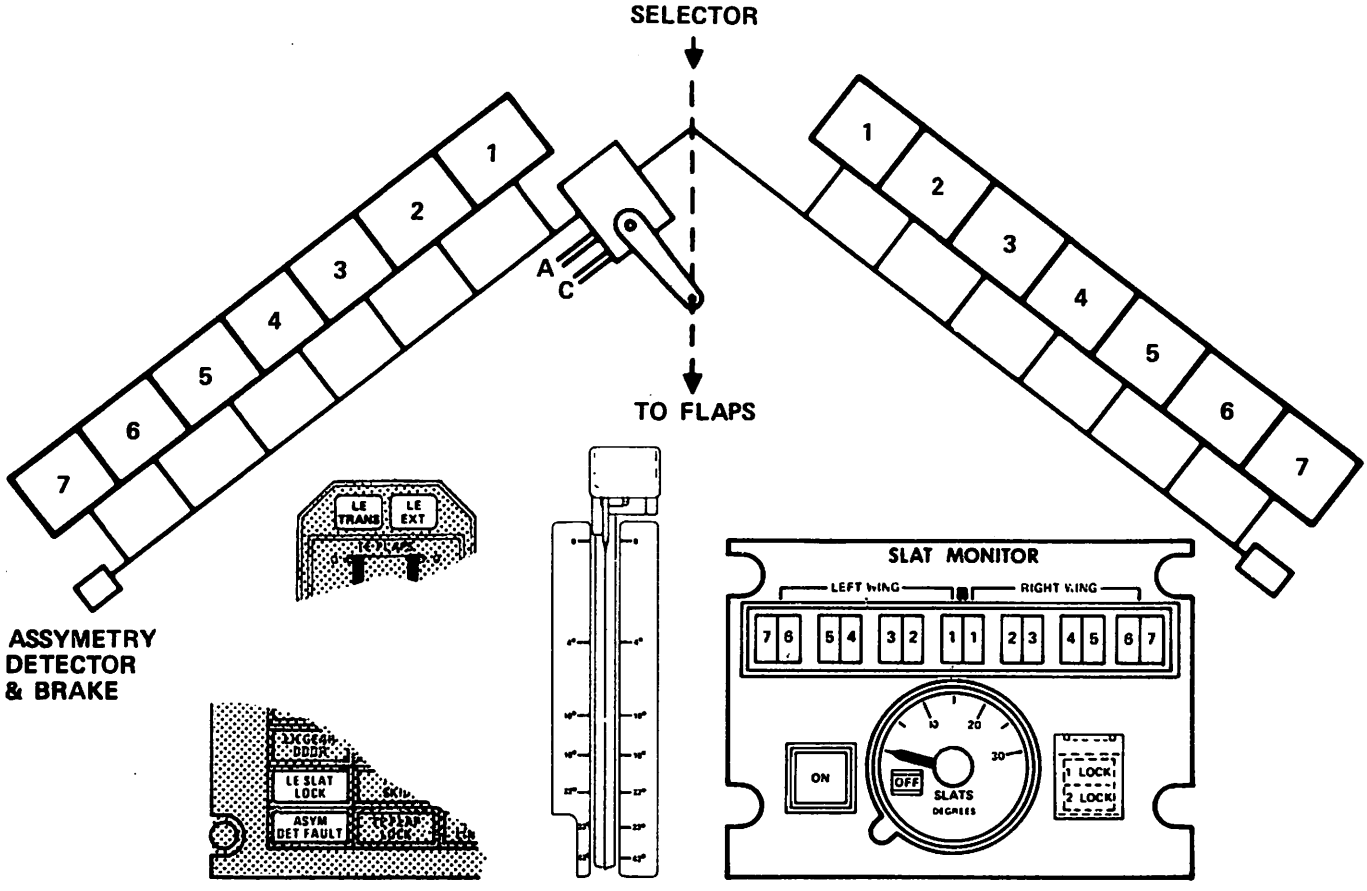
AILERON SCHEMATIC



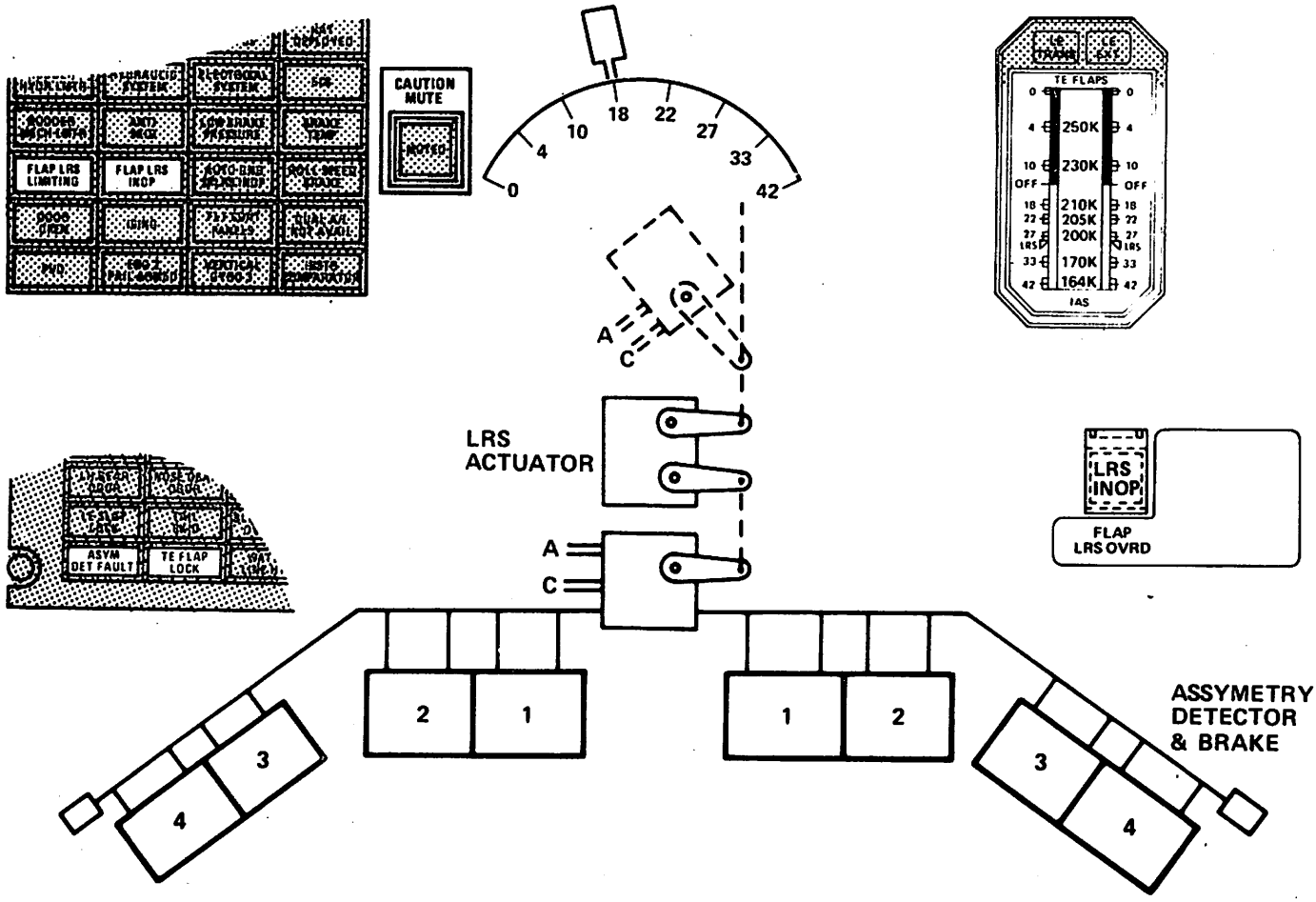
SPOILER SCHEMATIC



SLAT SCHEMATIC



FLAP SCHEMATIC



AVIONIC FLIGHT CONTROL SYSTEM

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AVIONIC FLIGHT CONTROL SYSTEM

INTRODUCTION A.F.C.S.

The term "Avionic Flight Control System" embraces flight instruments, auto pilots, flight directors, speed control. roll out and take off guidance. The flight controls electronic systems (FCES) also come under the same grouping but these are dealt with under Flight Controls.

Flight Instruments

There are duplicated servo driven flight instruments on the left and right instrument panels as follows:-

Attitude Director Indicators	= ADIs
Horizontal Situation Indicators	= HSIs
Airspeed/Mach Indicators	= AS/MIs
Altimeters	= ALTs
Vertical Speed Indicators	= VSIs
Radio Altimeters	= R/ALTs

Standby instruments are located on the centre instrument panel and on the windscreen pillar they are:-
Standby Compass
Standby Horizon
Standby Airspeed Indicator
Standby Altimeter

Only the Horizon is electrically driven.

Auto Pilots

The Auto Pilot Flight Director System (APFDS) has two separate auto pilots and two independent flight directors although some computer functions are common to an auto pilot and its related flight director.

Only one auto pilot can be engaged throughout most of the flight profile with the other available as an alternate in case of failure. This is true of all modes until the engagement of Approach/Land.

When A/Land is selected the other auto pilot can be engaged to operate in parallel with the first engaged AP.

The integrity of the system operating with two auto pilots satisfies the requirements for CAT 3 automatic landings.

Flight Directors

Technically both flight directors can be engaged together from before take off until after landing, but there are operational limitations.

They can be used as monitors in automatic flight or, in Manual Flight, as command directors for both cruise and ILS approaches.

Speed Control

Auto throttle can be engaged at any time but operationally will be limited to initial approach through to automatic landings.

The Auto Throttle System (ATS) has two channels, No.1 normally controls, with the other as monitor. No.2 is also available to control if No.1 fails. All three throttles are controlled by the operating channel to maintain the IAS datum set on the thrust panel.

Speed Control continued.

Regardless of the datum IAS the power demand is never allowed to fall below a level that would permit the speed to drop below 1.3 Vstall. This is referred to as operating in the ALPHA mode.

The system automatically goes into the ALPHA mode during the latter stages of the approach until the throttles close during the flare.

Align/Rollout

The Yaw Stability Augmentation System starts to remove drift at 150 feet on final approach of an automatic A/L sequence and, after touch down, controls the aircraft on the runway centre line with limited automatic nosewheel steering.

Para-Visual Directors

If the automatic Roll-Out control is disengaged, the Para-Visual Directors (PVD) will unshutter and provide centre line guidance. PVD is also used during CAT 3 take-offs as centre line reversionary guidance until rotation.

Go-Around

The APFDS has an automatic and manual "Go-Around" capability.

Status/Mode Indicators

The AFCS status indicator shows the operating state of the auto pilot pitch and roll channels and auto throttle system.

Control Wheel Steering (CWS) permits manual control of the auto pilot servos but leaves the aircraft maintaining the desired attitude when manual control is released. The Command mode (CMD) of auto pilot operation is associated with Pitch and/or Roll modes as indicated on the AFCS Modes indicator.

The Modes Indicator can show when a mode has been preselected but is not yet effective, i.e., VOR ARM, ALT ARM or when it is acquired or captured, i.e., VOR, ALT.

MANOMETRIC INSTRUMENTS AND AIR DATA COMPUTERS

INTRODUCTION

The manometric instruments can be divided into two groups. One comprising servo instruments remotely controlled by air data computers, the other having instruments directly operated by pressure changes.

AIR DATA COMPUTERS

General

There are two ADCs, No.1 normally controls the left servo instruments and No.2 the right.

No.1 also generates height and speed signals for autopilot A and the left flight director while No.2 similarly supplies autopilot B and the right flight director. They both provide speed information to the speed control system, which incorporates auto throttle, and also provide control and warning signals for the flight controls and other systems.

Operation

Pressure, static and temperature inputs from the pitot/static and temperature probes are processed in the ADCs with static source corrections applied where necessary. All inputs are converted to electrical outputs which may be continuous for controlling servo instruments, or switches operating at specific speeds or heights. A list of the systems affected, other than AFCS follows the description of instruments.

Safeguards

Monitors within the ADCs check the signals to associated instruments - if these are not valid the appropriate fail flag(s) shows.

In addition, monitoring occurs within the instruments and an invalid signal or loss of power will bring the flag(s) into view.

Left and right instruments are compared and, with excessive differences, there is an MWS INSTR COMPARATOR warning and the appropriate annunciation on the left and right instrument comparators - See Instrument Comparator.

An instrument alternate select panel enables the Captain or P2 to select his instrument to information from the other side - see Instrument Source Select.

TOLERANCES/ LIMITATIONS

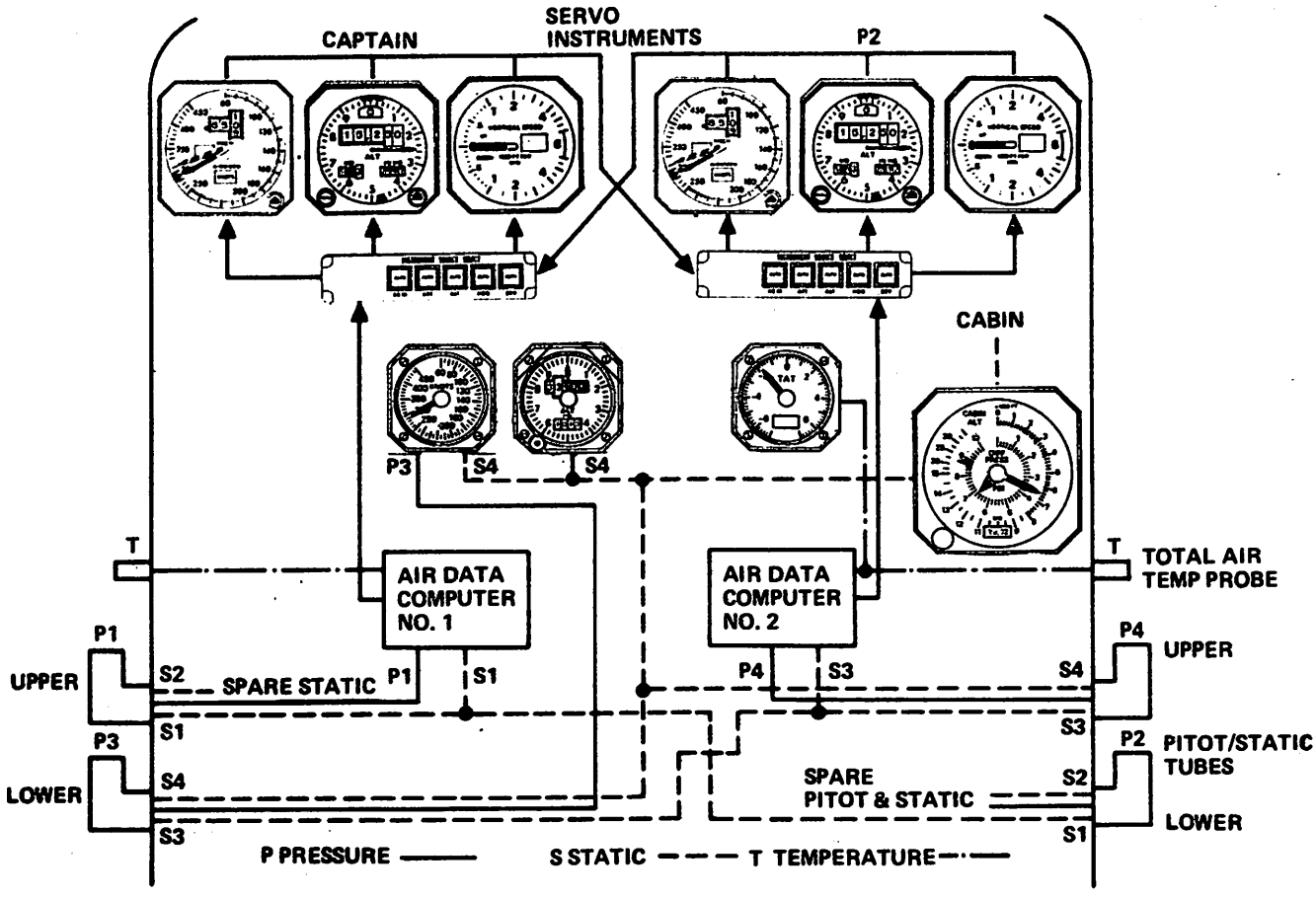
See Vol.1 Flight Management AFCS.

PITOT/STATIC AND TEMPERATURE PROBES

Four pitot/static and two total air temperature probes are positioned symmetrically either side of the fuselage below the flight deck windows.

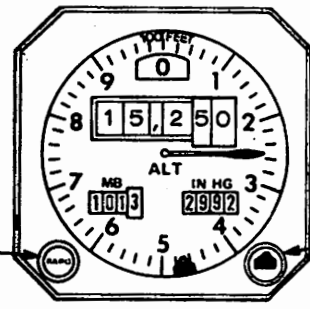
The probes have anticing elements. These are dealt with in Ice and Rain Protection.

PITOT / STATIC SYSTEM

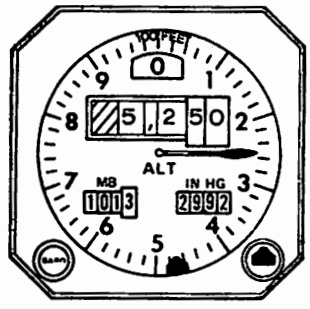


ADC INSTRUMENTS

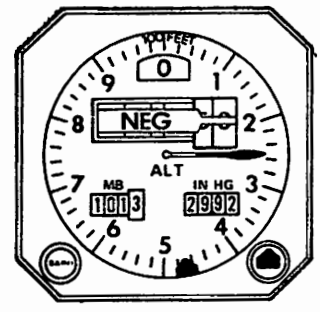
ALTIMETER Range = Minus 1,000 feet to 50,000 feet



Above 10,000 feet



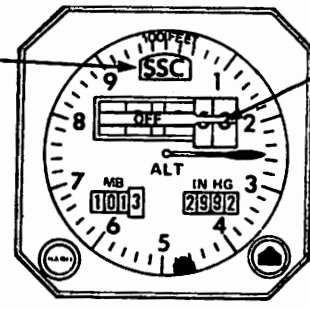
Below 10,000 feet



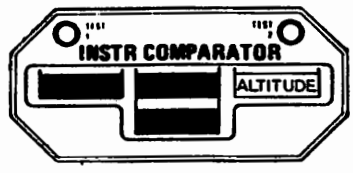
Below Sea Level

Fault Indications

i) Power failure
ii) Static source correction invalid.



i) Power failure
ii) Signal from ADC or within instrument invalid.



Both comparators operate together.

(left and right inst. panels)

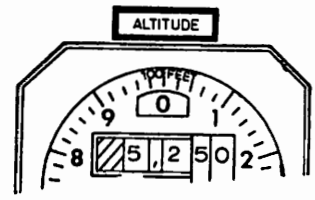
If the height signals significantly differ between ADC inputs to the instruments (80 - 240 ft) (this tolerance is doubled if VSI exceeds 800 FPM).

MWS caution

at any time the comparators operate.

ALTITUDE ALERT

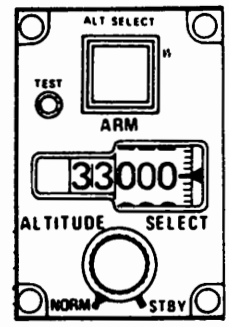
The system gives warning of approach to, or deviation from, selected servo height by warning lights on the left and right instrument panels and from the aural warnings unit in the roof.



Operation

The required height is set up at the Alt Select panel on the glareshield. The dual function switch selects NORM or STBY and also sets the altitude select scale above.

Operationally, the altimeter selector will be left at STBY with P2's altimeter providing the reference height signals and NORM will only be selected with a failure of the right instrument.



NORM	STBY
selects	selects
Capt's	P2's
Altimeter	Altimeter

Example of use - altitude set 33,000:-

at 32,250 both alert lights on
at 32,750 both alert lights out

ALTITUDE Steady

and 1½ second aural warning sounds. 'C' chord

If aircraft deviates from the selected altitude

at 32,750 (33,250) the altitude alert lights flash until the aircraft returns within ± 250 ft of the selected height, or a new height is selected.

ALTITUDE Flashing

The aural warning sounds as the aircraft deviates and again as height is regained. 'C' chord

When a new height is being set the aural and visual warnings are inhibited.

Testing

Press the TEST button on the panel to override its warning inhibit whilst changing the Altitude Selected.

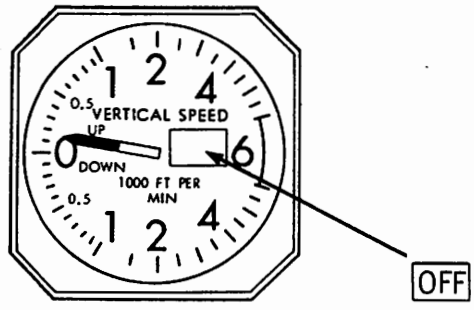
FAIL Flag

This appears in the SELECT window with invalid signals

Altitude Arm

This is an autopilot/flight director function dealt with in APFDS.

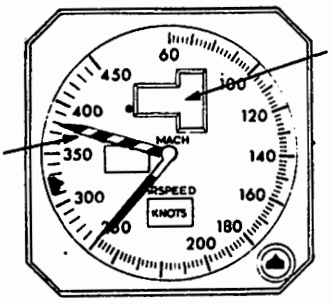
VERTICAL SPEED IND.

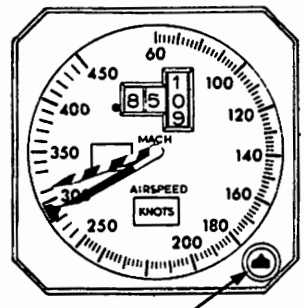


Failure

The VSI off flag will show with:-
(i) power failure
(ii) invalid signals from the ADC and within the instrument.

AIRSPEED/MACH IND. Range 60 to 450 kn, 0.500 to 0.900 m.





Overspeed Warnings

The VMO pointer displays limiting speed and varies with altitude. It will indicate approximately 350 at sea level and 375 knots at 10,000 ft.

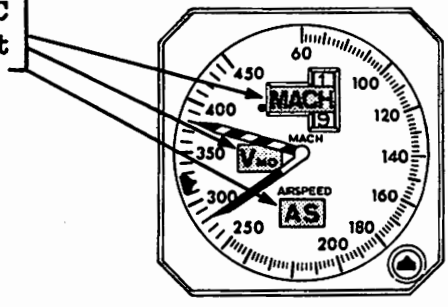
The VMO indication will decrease above 25000 ft.

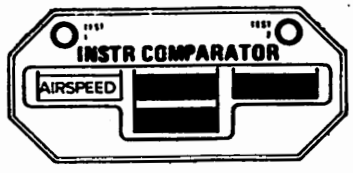
The Mach warning operates at 0.88 Mach.

The above operate the aural overspeed warning (clacker) if limits are exceeded.

Fault Indications

(i) Power failure
(ii) Invalid signals from ADC or within the instrument





Both comparators operate together.

(left and right inst. panels)

if the airspeed signals at the instruments differ significantly (6 - 10 kn)

MWS caution

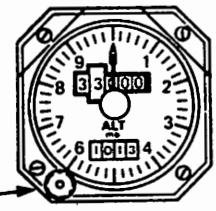
When the comparators operate.

STANDBY MANOMETRIC INSTRUMENTS

These are located on the centre instrument panel.

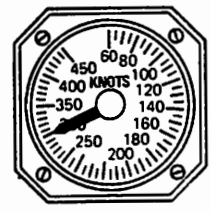
ALTIMETER

The altimeter is a non-electric directly capsule operated unit



AIRSPEED INDICATOR

The ASI is a non-electric directly capsule operated unit



Tolerances/Abnormal Management

See Flight Management AFCS and Radio.

Height and Speed Inputs to Other Systems

System	From
Autopilot/flight directors	ADCs
Speed control system	ADCs
Mach trim and feel	ADCs
Rudder limiter	ADCs
Flap LRS	ADCs
Flight recorder	ADCs
Transponders	ADCs
Slat out of position	ADCs
Undercarriage not locked down	ADC1
Overspeed warning (VMO/MMO)	AS/M.INDs

ATTITUDE SYSTEMS

GENERAL

Aircraft attitude information is provided by vertical gyros (VGs). Three VGs are located in the forward avionics service centre.

Vertical Gyros 1 and 2 control respectively the attitude displays of the left and right attitude director indicators (ADIs).

No. 3 VG provides an alternate attitude facility in the event of 1 and/or 2 VG failure to ensure adequate attitude presentation in the flight deck.

A standby horizon on the centre instrument panel gives additional attitude presentation independent of the three VGs.

The vertical gyros provide additional attitude signals to other sub systems within the Auto Flight Control System (AFCS).

ATTITUDE DIRECTOR INDICATORS

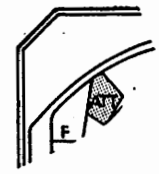
General

The instrument provides an attitude display, speed control information, localiser and glidepath deviation, flight director demands and radio decision height indications.

Attitude

This is presented by a sphere with horizon and pitch scale markings referenced against the aircraft symbol and centre datum. A bank pointer indicates against the bank scale.

With power failure it rotates clockwise to almost 90°.



Attitude Fail Flag

This will always appear for power failure or invalid signals from the associated vertical gyro or within the instrument.

VG3 Failure

An MWS warning will appear at any time power is lost or the signals from VG3 are invalid.

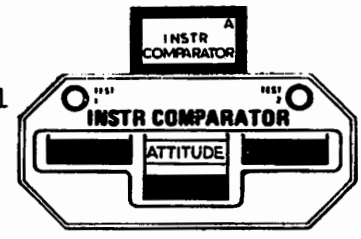
Attitude Comparison

A separate comparator unit monitors the attitude information displayed on the left and right instruments comparing them with VG3.

If there is a significant difference in pitch or roll (more than 5 degrees) the fail flag (or Vertical Gyro 3 display) will indicate the VG or attitude system that is unreliable.

With attitude failures ALTN ATT is selected and VG3 is used to control the left and/or right Attitude Display(s).

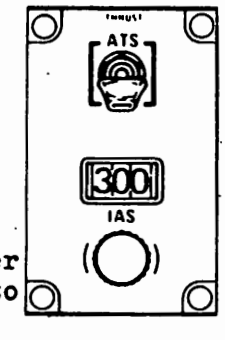
This means that the system cannot identify a suspect display if it is only a comparison error and so the indication will be MWS and Instrument Comparator. See Instrument Source Select.

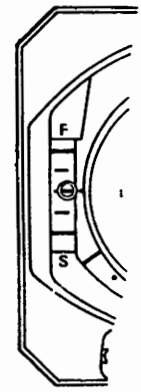


Fast/Slow Indication

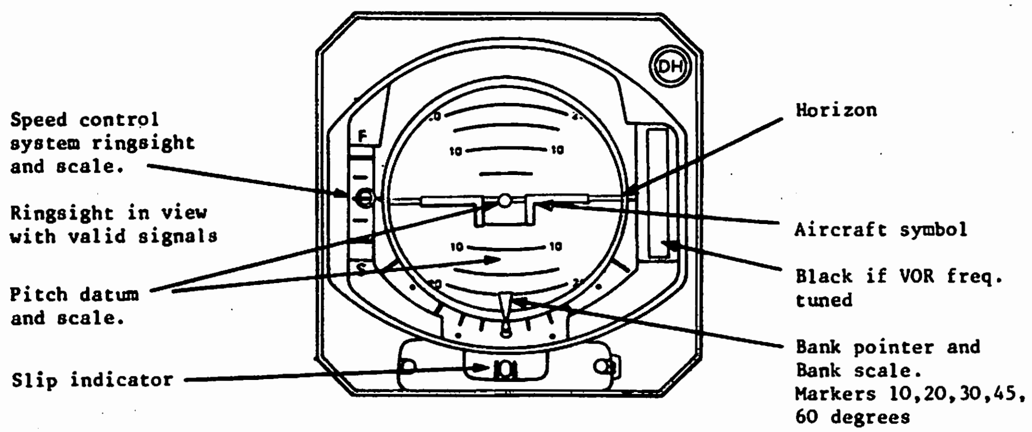
This is related to the Speed Control System, left No.1 and right No.2. The datum IAS is set on the Thrust panel and the ringsight indicates if the aircraft's speed is greater or less than the datum.

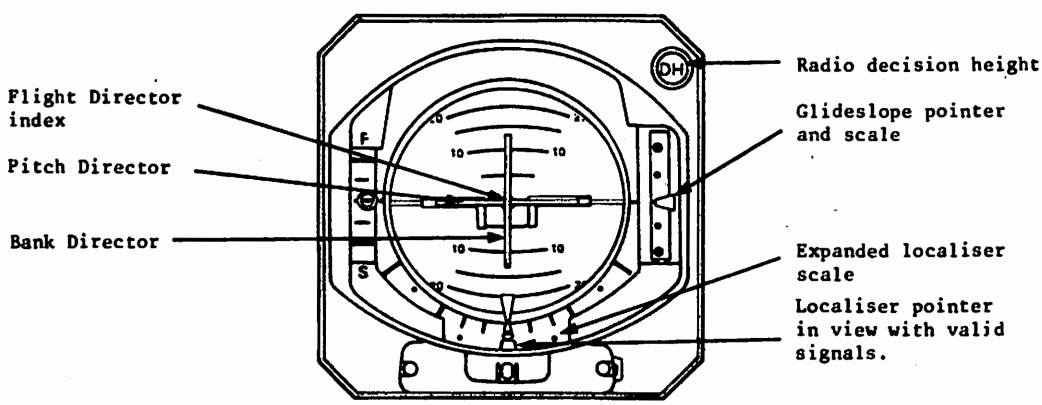
If the aircraft operates in the stall margin an ALPHA flag covers the IAS counter and the ringsight will indicate relative to the Alpha datum (typically 1.3Vs).
See Speed Control System.

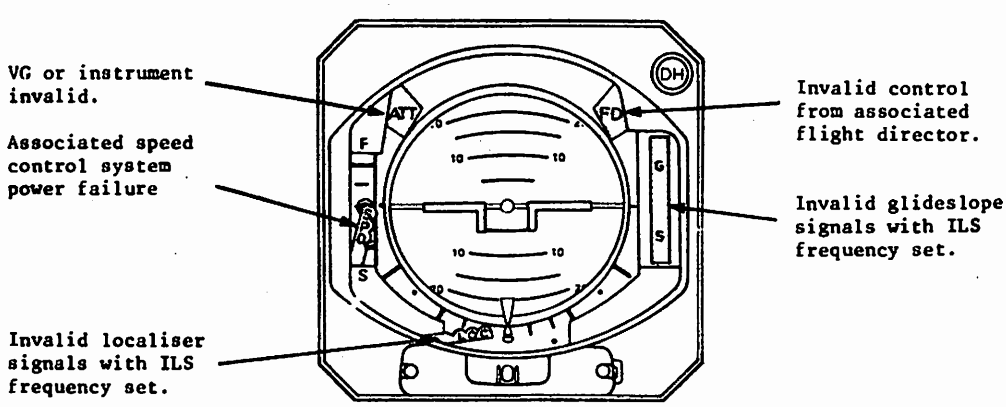




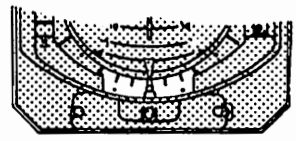
ATTITUDE DIRECTOR INDICATOR



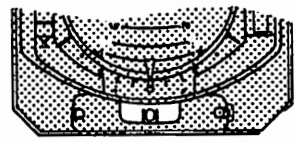




Localiser Indication The localiser scale is expanded on the ADI and full scale deflection approximates to 1 degree deviation. Full localiser deviation is shown on the HSI.

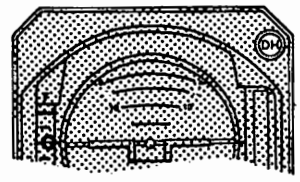


Flight Director Index and Fail Flag These are dealt with under Auto Pilot/ Flight Director Systems.



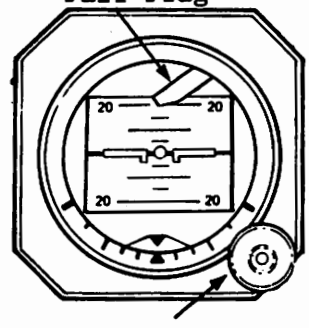
Slip Indicator A conventional ball indicator.

DH light This is controlled by the adjacent Radio Altimeter.



Tolerances/Abnormal Management See AFCS and Radio Flight Management.

STANDBY HORIZON



General This unit is electrically driven with an horizon display similar to the ADI but independent of the main VG system.

Caging Pulling the knob will cage and erect the gyro. Pulling and turning clockwise locks the caging mechanism.

Fail flag This will show for power failure or if the gyro is caged.

ATTITUDE INPUTS

The following systems receive attitude information as indicated:-

	VG1	VG2	VG3
Autopilot/flight directors	A	B	A&B
Speed Control System		2	1
Weather Radar	1	2	
Compass System			1&2
Flight recorder	1		

COMPASS SYSTEMS

GENERAL

The two compass systems display heading information on the left and right Horizontal Situation Indicators (HSIs) and on the two Radio Digital Distance Magnetic Indicators (RDDMIs).

When operating as a magnetic compass, flux valves at the left and right wing tips provide control information to update the basic directional gyro control.

The flux valve(s) can be switched out of the system when the associated HSI and opposite RDDMI cards will respond to DG control only.

COMPASS CARDS

No.1 compass drives the left HSI card and the right RDDMI card. No.2 controls the right HSI and left RDDMI card.

With failure the ALTN HDG selection can slave an HSI card to the other HSI but not the RDDMI card.

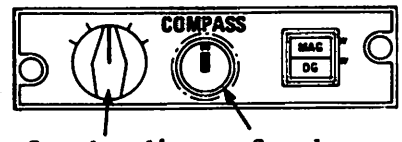
COMPASS CONTROLLERS (2)

These are located in the overhead panel.

MAG/DG Switch

In - MAG illuminated, associated flux valve supplying magnetic data.

Out - DG illuminated - flux valve disconnected.



Set heading control

Synch indicator for MAG mode.

Synchronising Indicator

Functions in the mag mode to indicate magnetic alignment between flux valve and gyro when needle at datum. For fast synchronisation select DG then MAG.

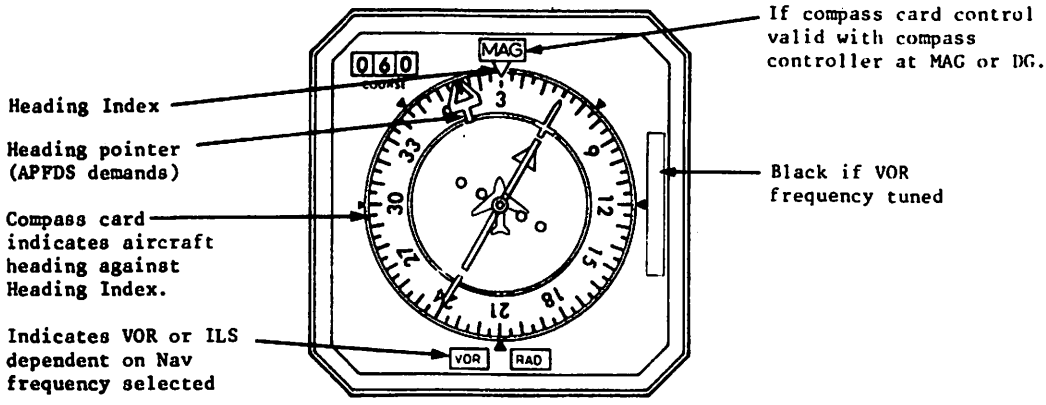
Set Heading Control

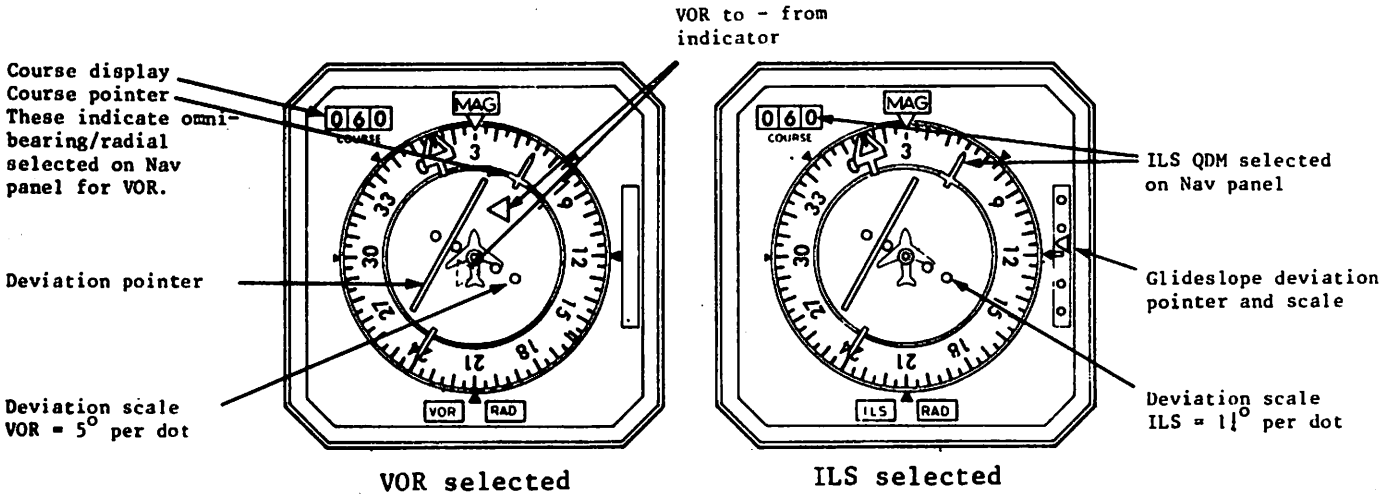
In circuit when DG or MAG is illuminated. Selection to first switch mark from centre gives slow rotation left or right, second marked position provides fast rotation.

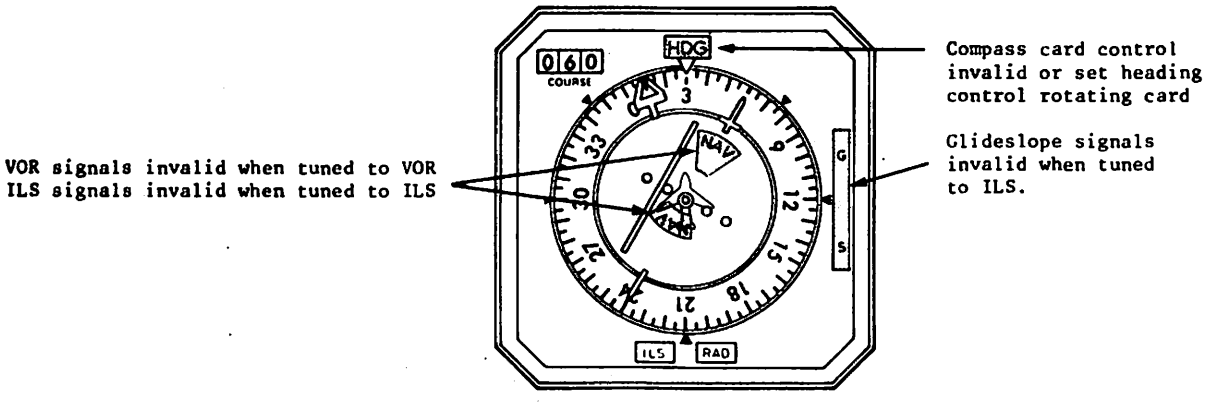
Note: MAG indication on HSI shows irrespective of MAG/DG selection.

HDG fail flags show on HSI and associated RDDMI when cards are rotated by the Set Heading Control.

HORIZONTAL SITUATION INDICATOR





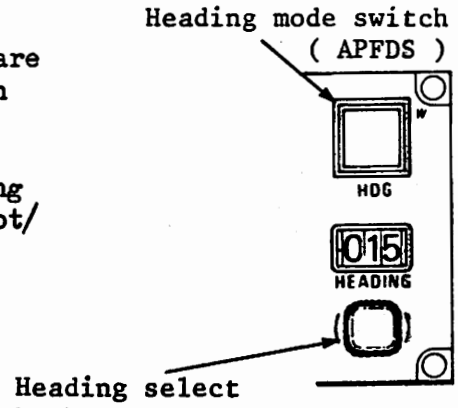


HORIZONTAL SITUATION INDICATOR

Heading Pointer

Both left and right Heading Pointers are controlled by a single setting knob on the Heading/Pitch mode panel.

The facility provides a means of flying selected headings through the autopilot/ flight director system, see APFDS.

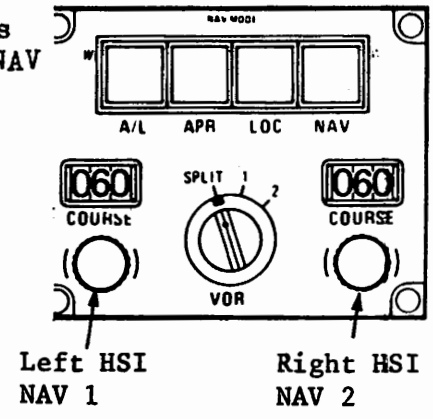


Course Pointer and Course Display

The left and right Pointers and Displays are controlled by setting knobs on the NAV MODE panel, the pointer and display remotely indicating the course selected on the nav mode panel.

These only have significance when displaying radio deviation on the HSI.

Use of the nav mode switches and the VOR switch are dealt with in APFDS .



To/From Indicator

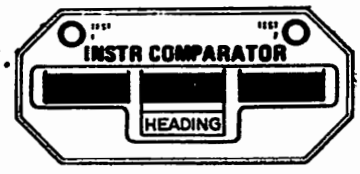
Appears at the head or tail of the Course Pointer relative to the omni bearing selected when a VOR frequency is tuned.

Radio Failure

With VOR or ILS failure, ALTN DEV can be selected using the Nav receiver signals going to the other HSI. (See Instrument Source Select).

For a correct presentation of the horizontal situation, it will be necessary to set the course selector to the same QDM/omni bearing as set on the serviceable unit.

Comparator Warnings



Both comparators operate together.

(left and right inst. panels)

With a difference of 6° to 15° between HSIs dependent on Bank angle.

MWS Caution

if comparators operate.

RADIO DIGITAL DISTANCE MAGNETIC INDICATOR

Heading datum

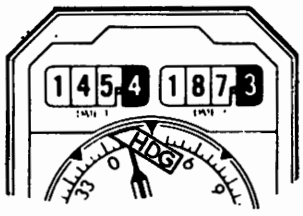
General

This instrument combines RMI bearing and DME indications. These aspects will be dealt with in Radio - Section 8.

The compass cards are controlled by the remote compass units as follows:-

Nr 1 compass unit to right RDDMI.
Nr 2 compass unit to left RDDMI.

This arrangement is unchanged by ALTN HDG selection.



Heading failure

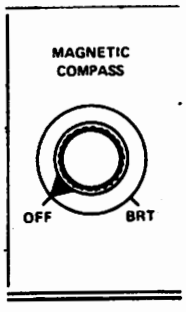
The flag will appear with invalid control signals, instrument failure or Set Heading Control operated.

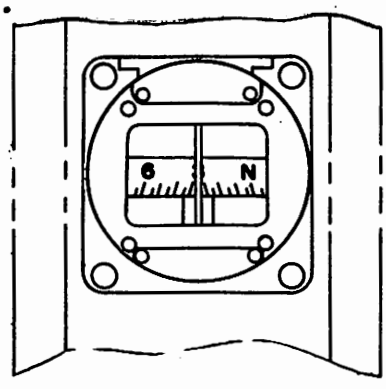
STANDBY COMPASS

This small magnetic compass is mounted on the central windscreen pillar below the eyebrow panel.

MAGNETIC COMPASS Switch

OFF - BRT. A rotary switch controlling the illumination of the standby compass.

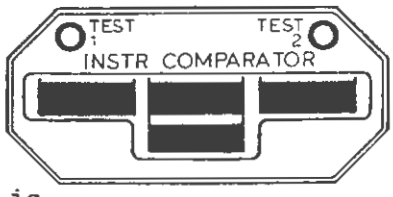




INSTRUMENT COMPARATOR

General

This unit compares information from similar sources and gives warning on the two indicators that dual systems differ excessively.



With three attitude systems it is possible for the system to establish which single unit is in disagreement with the other two and bring up the appropriate warning flag or VG 3 MWS display.

Once ALTN ATT has been selected an attitude disagreement will be displayed on both the instrument comparators and not at the ADI.

Comparator Warnings

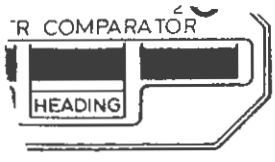
Discrepancies in excess of the following tolerances will bring up the associated warning:-

i. 5° in pitch or roll between ADIs with ALTN ATT selected.

ii. 6 to 10 kts - tolerance increases with airspeed.

iii. 80 to 240 feet (measured at instrument inputs) - tolerance increases with altitude and doubles with high indicated V.S.

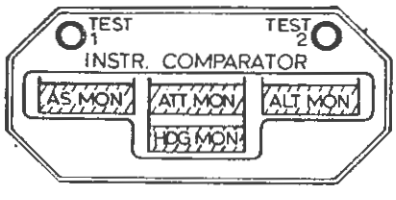
iv. 6 to 15° - tolerance increases with bank angle.



Monitor Warnings

The appropriate annunicators on both sides will show if there is power failure to a system monitor. This warns that a discrepancy will not be detected by the comparator.

If the input supply to the comparator fails all monitor annunciators will show.



Comparator Test

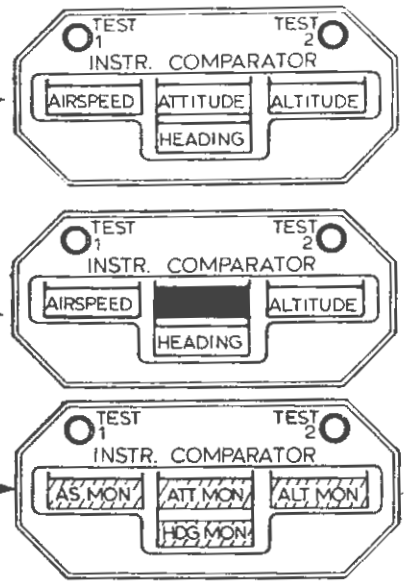
TEST 1 - When pressed individually both show →

The associated ATT fail flag is also displayed.

When both test 1 are pressed simultaneously both show →

The MWS VERTICAL GYRO 3 A is also displayed.

TEST 2 - When pressed - both show →



MWS Caution

INSTR COMPARATOR A

At any time the comparator or monitor annunciators show.

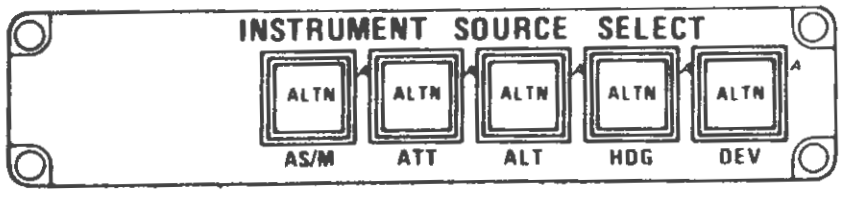
INSTRUMENT SOURCE SELECT.

General

This facility permits certain instrument displays to be connected to an alternative source of information if the normal source fails.

If the instrument display is at fault, and not the source of control, selecting the ALTN source will not clear the fault indications.

INSTRUMENT SOURCE SELECT PANEL



There is a source select panel on both left and right instrument panels.

ALTN SOURCE SWITCHES

AIRSPEED/MACH	OUT -	Connects left (right) AS/M ind to ADC 1 (ADC 2). Permits other side to make ALTN select.	Switch dark
	IN -	Disconnects left (right) AS/M ind from ADC 1 (ADC 2) and connects to opposite AS/M ind. Inhibits opposite ALTN AS/M select.	Lit
HEADING	OUT -	Connects left (right) HSI card to compass 1 (Comp 2). Permits other side to make ALTN select.	Switch dark
	IN -	Disconnects left (right) HSI card from Comp. 1 (Comp. 2) and connects to opposite HSI. Inhibits opposite ALTN HDG select.	Lit
ALTITUDE	OUT -	Connects left (right) altimeter and VSI to ADC 1 (ADC 2) Permits other side to make ALTN select.	Switch dark
	IN -	Disconnects left (right) altimeter and VSI from ADC 1 (ADC 2) and connects them to opposite altimeter and VSI. Inhibits opposite ALTN ALT select.	Lit
DEVIATION	OUT -	Connects left (right) HSI deviation bar and glideslope pointer to NAV 1 (NAV 2). Permits other side to make ALTN select.	Switch dark
	IN -	Disconnects left (right) HSI deviation and glide slope pointers from NAV 1 (NAV 2) and connects them to the opposite NAV. Inhibits opposite ALTN DEV select.	Lit

ATTITUDE

OUT - Connects the left (right) ADI attitude display to VG1 (VG2).

Switch dark

IN - Disconnects the left (right) ADI attitude display from VG1 (VG2) and connects it to VG3. Arms the instrument comparator for ATTITUDE warnings

Lit

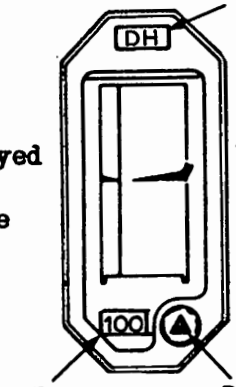
Note - Because VG3 is an independent source both ADIs can be selected to ALTN ATT at the same time.

RADIO ALTIMETER (2)

General

Radio height information is displayed on radio altimeters at the left and right instrument panels. These are independent units.

The indicators show wheel height above the ground and are limited to measurement below 2500 ft.



DH light

Above 2500R

DH counter

DH setting knob

Setting Knob

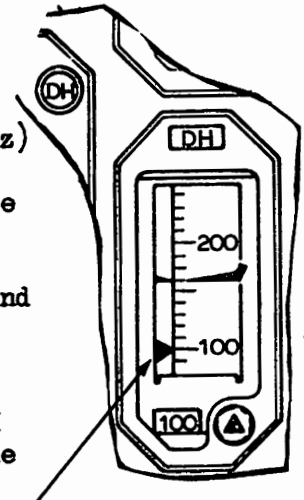
This adjusts the DH counter and index.

D.H. Indication

At 50 R above decision height an intermittent tone (1,000 herz) is heard in the headsets by P1, P2 and P3. The pulsing rate increases as DH is approached.

At DH the audio signal ceases and both DH lights are lit.

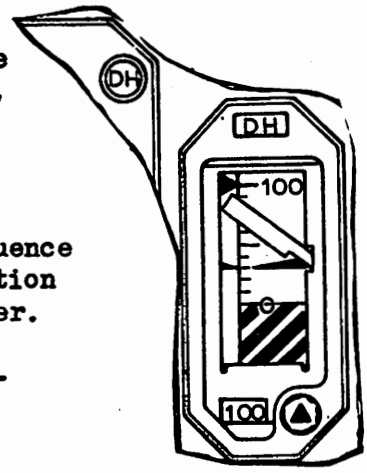
Pressing the radio altimeter DH light will extinguish it and the associated ADI lamp.



DH index

Fail Flag

This will appear at any time the receiver or instrument fails or, below 2500 R, if the signals are invalid.
The scale may also disappear.



Radio Switching Heights

The automatic approach/land sequence depends on radio height information from at least one Radio altimeter.

Specific switching heights are:-

1500 R - approach/land track
150 R - Align
50 R - Flare
5 R - Roll Out

Below 50 feet the height information is used to control the flare.
See APFDS flare phase

INSTRUMENT POWER SOURCES

	Left Panel	Right Panel
ADI (ATT)	AC S/BY	AC BUS 2
HSI (HDG)	AC S/BY	AC BUS 2
AS/M	AC S/BY	AC BUS 2
ALTM	AC S/BY	AC BUS 2
VSI	AC ESS	AC BUS 2
RAD ALTM	AC ESS	AC BUS 2
RDDMI (HDG)	AC BUS 2	AC ESS

Standby Horizon AC S/BY
Vertical Gyro 3 AC BUS 1

LOCATION OF REMOTE UNITS

The equipment controlling the above instruments is located in the Forward Electronic and Mid Electrical Service Centres.

TOTAL AIR TEMPERATURE GAUGE

Located on the centre instrument panel, it is controlled by the right hand temperature probe.

The instrument is electrically driven and the OFF flag will be in view if this power source fails.

TAT Probe Heater

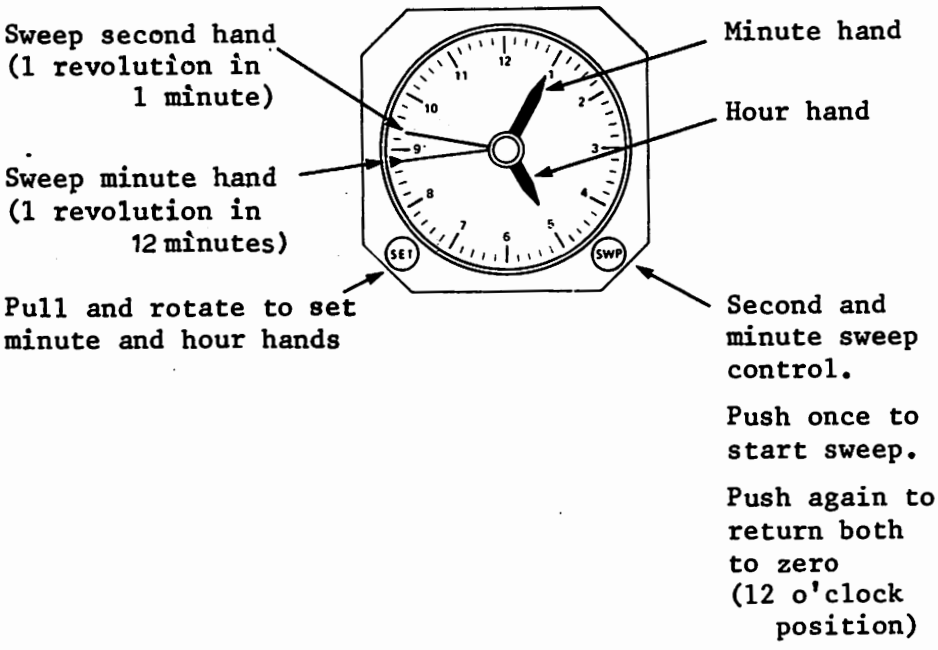
This is dealt with in Ice and Rain protection.

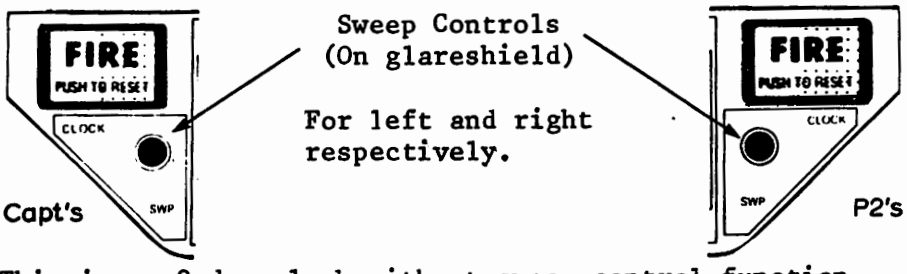
The heating will not affect temperature readings when there is adequate airflow.

CLOCKS

CAPTAINS & P2

These are Electric Clocks with remote sweep control.





SYSTEMS STATION

This is an 8 day clock without sweep control function.

i Turn to wind

ii Pull & turn to set hands

AUTO PILOT/FLIGHT DIRECTOR SYSTEM

GENERAL

The APFDS consists of two independent auto pilots and two independent flight directors.

Auto Pilots/Flight Directors

The auto pilots are referred to as AP 'A' and AP 'B', The left flight director is connected to the pitch and roll computers of AP 'A'.

The right flight director has a similar association with AP 'B' computers.

Only one auto pilot can be engaged throughout most of the flight regime. The second auto pilot can be selected when the APPROACH/LAND mode has been engaged.

Both flight directors can be engaged and display simultaneously through all modes of operation except TURBULENCE, when they bias out of view.

APFDS COMPUTERS

Each pitch and roll computer has a "Cruise" channel and a duplicated "approach/land" channel.

Cruise

"Cruise" in this context means all climb, cruise and descent modes including LOC and APR but excludes A/L.

Approach/land

With A/L mode selected and one AP engaged there is DUAL computation.

With the second AP engaged and radio height below 1500 ft there is DUAL-DUAL computation and any single failure will still leave the auto pilot system fully operational.

AUTO PILOT SERVOS

General

Auto pilot servos control the stabiliser and ailerons through the associated flying control jacks. Each AP has its own servo controls.

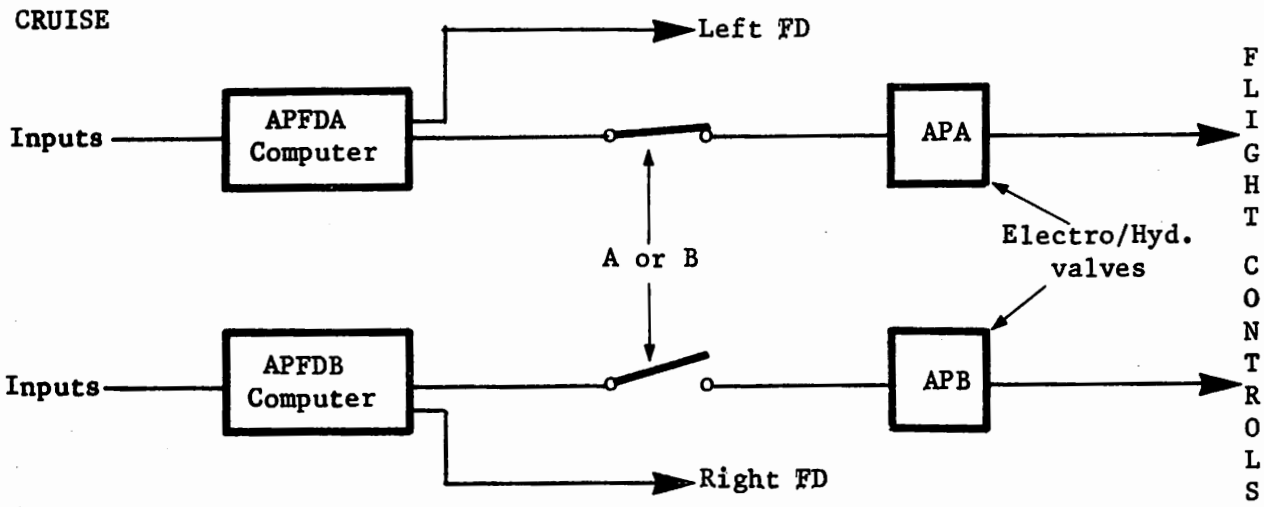
Stabiliser Control

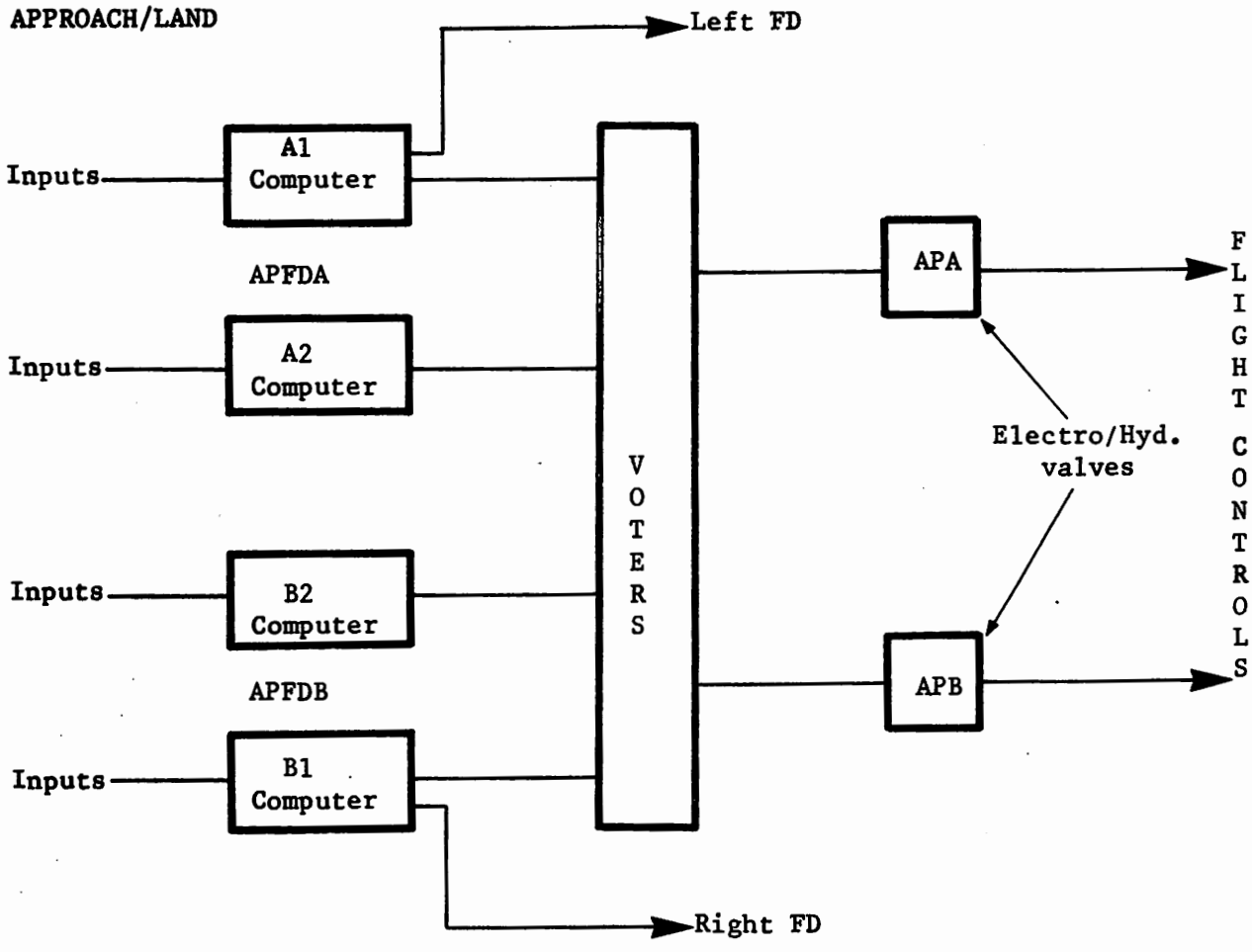
The AP servos operate the mechanical inputs to the hydraulic servos. Auto trim motors, controlled by the auto pilots, retrim when necessary. During automatic landings the auto trim is biased to a nose up position. This will cause the yellow trim warning flags to appear with stabiliser movement during a normal autoland sequence. See Section 6.

Aileron Control

The auto pilot servos operate on the left inboard aileron only but aileron interconnects ensure normal response on both left and right ailerons.

APFDS COMPUTERS





Rudder Control

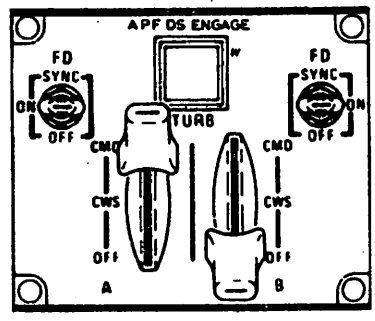
The auto pilot has no separate servo system to the rudder but inputs to the Yaw Stability Augmentation System provide turn co-ordination in all Cruise modes. After A/L track the yaw SAS changes its mode of operation in preparation for runway alignment and roll out control.

APFDS CONTROLS AND INDICATORS

Mode and engagement controls are located on the glareshield.

APFDS Engage Panel

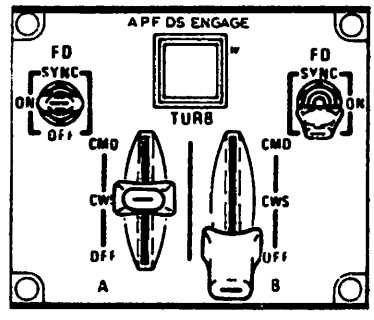
This contains auto pilot and flight director engagement - disengagement levers and the turbulence mode switchlight - this is dealt with under Modes.



Auto Pilot Levers

OFF

Associated AP is switched off. Lever cannot be moved from off if AP is invalid or except for approach land, if the other AP is engaged. It will spring to off if AP fails.



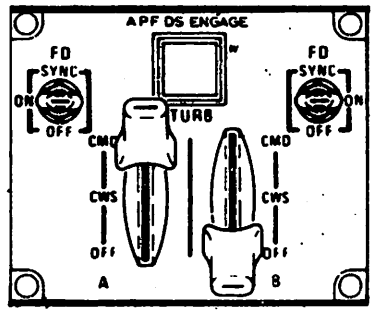
CWS

Control Wheel Steering function is selected. This is an initial engagement mode holding the aircraft in its attitude at the moment of engagement within limits.

Control wheel steering allows the aircraft to be manually flown through the engaged auto pilot - a force of 4 lb is applied to overcome attitude hold, the aircraft will follow command, on releasing pressure the auto pilot will hold the new attitude.

CMD

Command function. Initially this does not differ from CWS but does permit the engagement of all pitch and Nav modes. Pitch, Heading and Nav mode engagements override the CWS function when the mode changes from ARM to Capture.



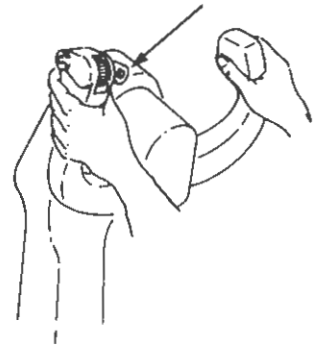
Operating Limits

Pitch - 18°
Roll - 35°
The above limits can be exceeded through CWS but will return to within the maximum limits. If the bank attitude is less than 3° the aircraft will hold current heading.

Operating limits related to modes are dealt with under each function.

AUTO PILOT DISCONNECT

The auto pilot(s) can be disconnected, with engaged lever(s) dropping to OFF



i By pressing either disconnect switch

ii Automatically due to invalid systems

or by manually selecting the auto pilot levers OFF.

DISCONNECT WARNINGS

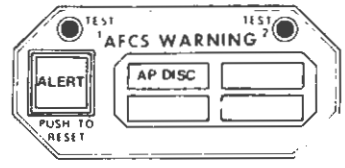
For any complete disconnect of the engaged autopilots there will be:

Aural

i A 2 second "wailer" through the aural warnings speaker.

Visual

ii Both AFCS warning ALERT lights flash with an AP DISC displayed



To cancel the AFCS warnings

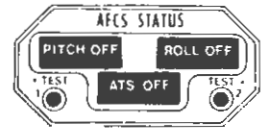
i Press the AP disconnect button on the control column following disconnect

or

ii Press the ALERT light on either side once to stop alert lights flashing. Press again to clear AP DISC annunciator.
AFCS Warning indicators are dealt with on Page 39.

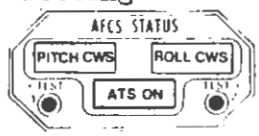
AFCS STATUS Indicators

These display the pitch and roll channel status of the engaged auto pilots and that of the ATS (auto throttle). Both indicators operate in parallel.

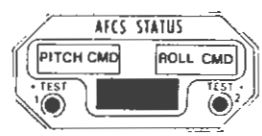


STATUS TEST

Pressing TEST 1



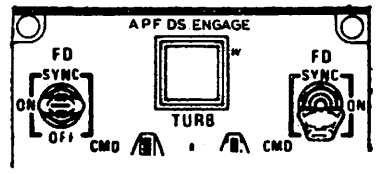
Pressing TEST 2

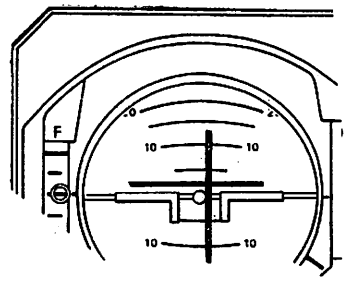


Flight Director Switches

OFF — Associated flight director switched off - indices parked and fail flag out of view.

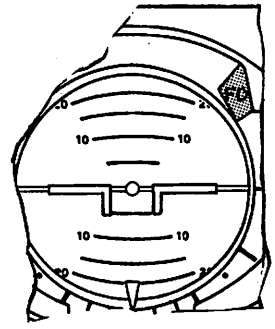
ON — Engages the flight director. With modes disengaged the indices will move to centre and command existing attitude hold. Both flight directors can be engaged simultaneously and operate through the mode switches selected for auto pilot operation. Without modes engaged the limits of flight director demand will be the same as the auto pilot but without a heading hold function.





SYNC — With modes disengaged and the aircraft attitude other than that existing at the time of engagement, this selection on either FD switch will synchronise both flight directors to existing attitude. SYNC is spring loaded to ON.

Flight Director Failure — The command bars go out of view and the FD flag appears with failure or invalid inputs.



APFDS OPERATING MODES

GENERAL — Controls for mode engagement are located on the Heading/Pitch modes panel and NAV modes panel. In addition there is the Turbulence mode switch on the APFDS engagement panel, and the Altitude ARM mode switch on the Alt Select panel.

All switches are momentary types, push once to engage and again to disengage the mode. The switch light is illuminated when the mode is engaged.

Compatible Modes — Any single pitch mode can be engaged with heading select or NAV & LOC modes.

VS or Alt can be engaged with APR or AL modes until glideslope capture.

Heading select can be engaged with Nav modes operating in the ARM condition but will disengage at Nav mode capture.

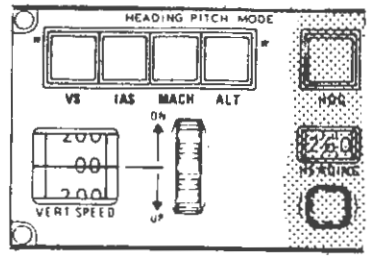
Compatible Modes (Cont)

Altitude select is compatible with any pitch mode until Altitude capture occurs.

Only single pitch and/or Nav modes can be engaged. The last selected mode overrides and disengages the previously engaged pitch mode or heading select/Nav mode - Engagement of IAS or MACH would disengage auto throttle.

Indications of engaged modes are shown on the mode indicators, examples of which are displayed from page 48.

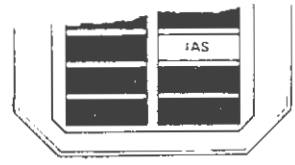
PITCH MODE PANEL



MODE

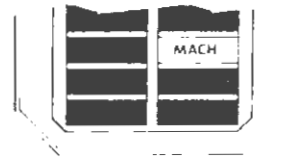
IAS

When pressed will maintain current airspeed. This datum cannot be changed with IAS engaged.



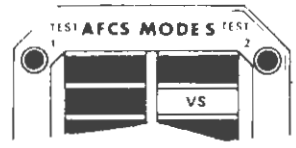
MACH

When pressed will maintain current mach number.



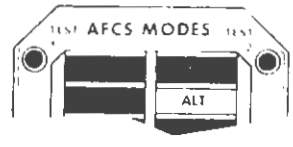
VS

Before engagement the vertical speed tape acts as a vertical speed indicator. When VS is engaged the VSI tape locks to current vertical speed but this datum can be adjusted with the VS control wheel. This is the only pitch mode datum that can be varied with the mode engaged. Range available is +4000 to -8000 FPM.



ALT

Altitude hold is the only mode that can put the auto pilot pitch channel into command (CMD) status with the engagement lever at CWS.

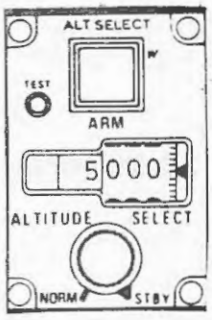


ALT (Cont)

When pressed the aircraft will lock to current altitude, the accuracy of tracking the required height will be dependent on the vertical speed rate when ALT is pressed.

ALTITUDE SELECT

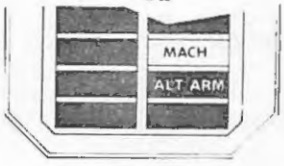
The Altitude select panel has two functions, firstly to select a height that will arm the altitude alert function dealt with on page 6. Secondly, to preselect a required altitude for capture by the APFDS.



ARM

With a height set, pressing the switch light will arm the APFDS for altitude capture. This arm mode can be engaged with IAS, MACH or VS, using any one pitch mode to reach the capture point. The pitch command bars can also display the selected pitch mode commands until the ALT capture point is reached.

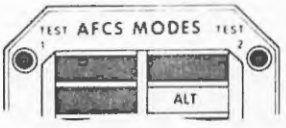
or



or

Altitude capture is determined by the vertical speed rate to give a smooth transition to the required height with a minimum of overshoot.

At capture the control mode disengages but the ARM light remains illuminated until tracking occurs when the ARM light extinguishes and the ALT switch light comes on.



Altitude select can be armed for anticipated clearance to a new height with altitude hold (ALT) engaged.

Note

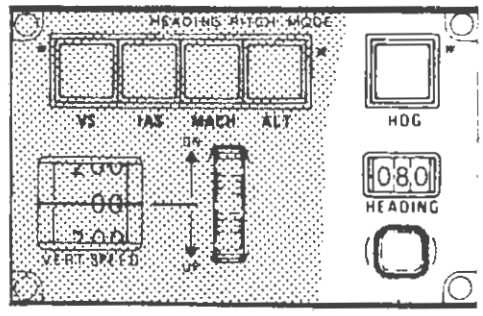
The required altitude must be set on the select panel before engaging ARM.

Once ARMED, any change in altitude setting will disengage the mode.

The height selected is relative to the selected control altimeter and its barometric setting, Normal - P1 and Standby - P2.

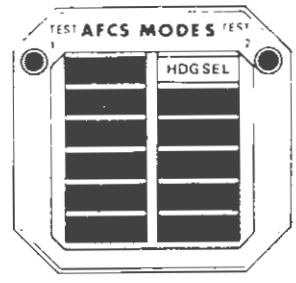
HDG

The heading select knob and switch light are located on the heading pitch modes panel.



HEADING SELECTOR

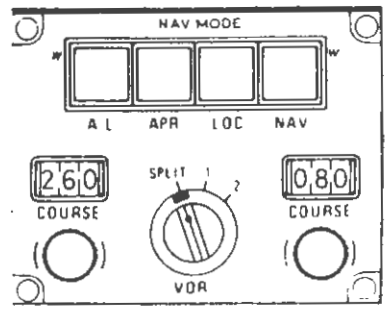
This control sets the heading pointer on both HSIs and provides turn control for the engaged auto pilot and bank demands for both flight directors when the HDG switch light is pressed. It will disengage any NAV modes except A/L track.



Bank limit is 28° at low speed reducing to 15° at high speed.

NAV MODES PANEL

These switch lights control modes with radio inputs. The last mode pressed will disengage a previous LOC/VOR mode with the exception that once A/L goes to A/L track it cannot be over-ridden by other Nav or heading modes.



Mode Sequence

All 4 modes sequence in a similar manner. When the switch light is pressed it will illuminate and, dependent on the aircraft's position relative to the radio facility will go into the ARM or capture mode.

At ARM, approach to the capture point can be through control wheel steering with the A/P lever at command or through the Heading Select mode using the auto pilot or flight directors.

Mode Sequence (Cont)

Capture can only occur if valid signals are present.

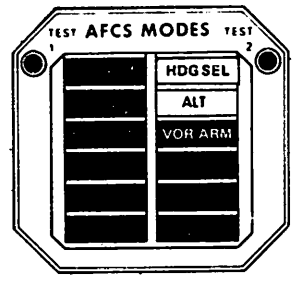
The point of capture will be dependent on the angle of attack. With large attack angles the aircraft will fly through the localiser or radial and couple from the other side of the beam.

Heading select would disengage at capture.

During localiser or VOR capture bank angle is limited to 28°.

When established the bank angle limits to 10°.

The aircraft is now in the track mode.



NAV

When pressed, arms for VOR capture.

VOR Switch

SPLIT

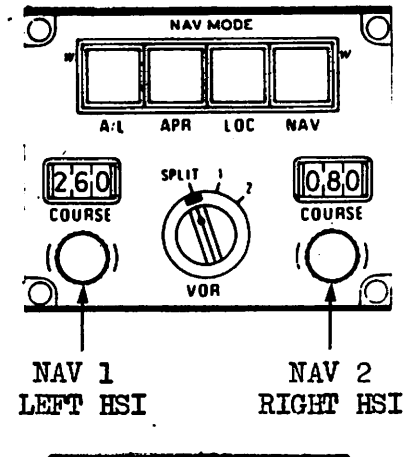
Selects the required Nav receiver. Will only hold away from this position with NAV mode pressed. At Split NAV 1 is connected to AP A and left flight director and NAV 2 supplies AP B and right FD. Only one auto pilot can be engaged.

1

The engaged AP and both FDs receive VOR signals from NAV 1.

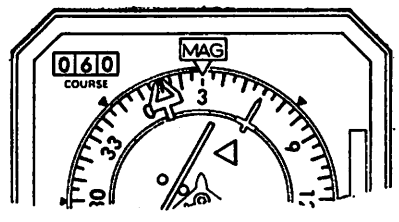
2

The engaged AP and both FDs receive VOR signals from NAV 2.



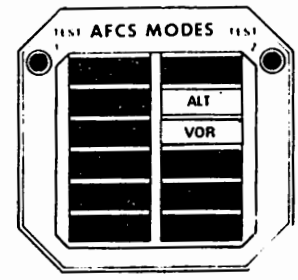
COURSE SELECTORS

Set the course pointer and counter on the associated HSI and select the required omni bearing in the Nav unit. The course selectors are also used to set the QDM for ILS approaches.



VOR Capture

The HDG SEL mode will disengage and VOR ARM is replaced by VOR. Capture point depends on intercept angle.



VOR Track

Bank limit is 10° when tracking the radial.

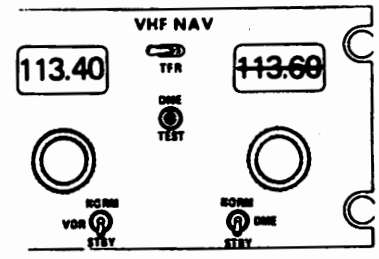
Overstation

When this point is sensed the radio signals are suppressed and the aircraft will maintain the existing track until station passage is completed.

If the outbound radial differs from the inbound then rotating the course selector will turn the aircraft on to a new track while over the VOR station and the APFDS will couple to the new radial when signals are adequate.

Frequency Change

Changing from one VOR frequency to another will not disengage the NAV mode. The APFDS remains engaged providing the system does not see an ILS Frequency. With the dual head Nav controllers the next required frequency can be preset and the TRNSFR switch used to effect selection.



ILS Modes

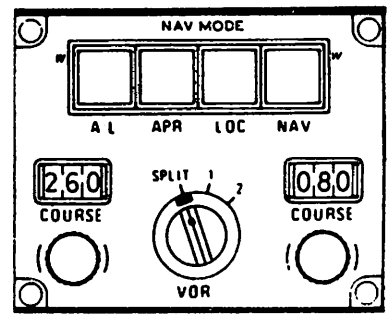
LOC, APR and A/L modes all use ILS inputs and the following is true for each mode.

i An ILS frequency must be selected before engagement

ii AP A and the left FD use NAV 1, AP B and the right FD use NAV 2

ILS Modes (Cont)

iii The VOR switch has no control function with ILS modes engaged. If a NAV mode was previously engaged the VOR switch will rotate to SPLIT as NAV disengages.



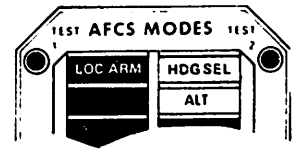
iv COURSE SELECTORS will be set to ILS QDM. This is particularly important for the ALIGN function during an autoland sequence.

v HDG SELECT can be used for pre-capture guidance.

vi Back Beam coupling is not available.

LOC

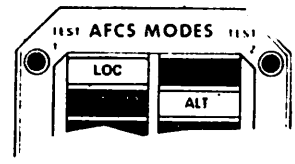
When pressed the LOC switchlight will illuminate and the mode is armed.



Localiser mode is compatible with any of the four pitch modes.

Localiser Capture

At the capture point HDG SEL would disengage and mode indications change. The capture point is dependent on intercept.

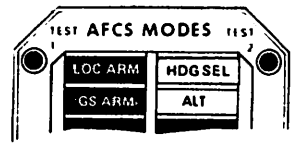


Localiser Track

When established the bank angle is limited to 10°.

APR

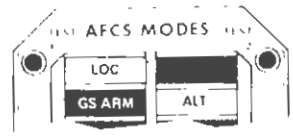
When pressed the APR switch light will illuminate with engagement. This mode is only compatible with VS and ALT pitch modes.



Both LOC and GS are armed on engagement. Glide slope capture cannot take place before LOC track is achieved.

Localiser Capture

HDG SEL will disengage & LOC replaces LOC ARM. Bank limit 28°.



Localiser Track

Bank limit reduced to 10° and GS capture can now take place.
For AFCS warnings see Pages 40&41.

Glideslope Capture

At the capture point any other pitch mode in use disengages and GS ARM changes to GS. The aircraft pitches down at a preset rate and is then controlled by any glideslope deviation.

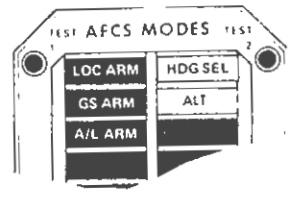
The flight directors demand pitch down and respond to deviation signals.

Approach/Land

Approach/Land can be engaged for Dual AP auto landings, single AP auto landings and for flight director approaches. In the latter case mode annunciations and warnings will be as for the APR mode but closer tolerances within the computer systems will produce better beam holding.

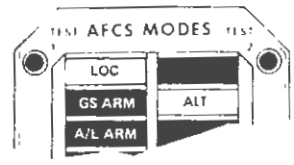
A/L

When engaged will override other engaged NAV modes. This mode can only be engaged with VS or ALT pitch modes.



Localiser Capture

This will disengage HDG SEL. Bank limit is 28°.

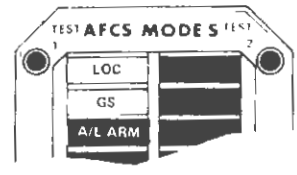


Localiser Track

Bank limit is now 10° and GS capture can now take place.

Glideslope Capture

Any other pitch mode will disengage and aircraft tracks localiser and glideslope.



Glideslope Capture (Cont)

Glideslope Capture cannot occur before localiser capture.

A/L ARM

This mode and those subsequently indicating at A/L are dependent on at least one auto pilot being engaged at CMD.

Switching heights are controlled by the Radio Altimeters.

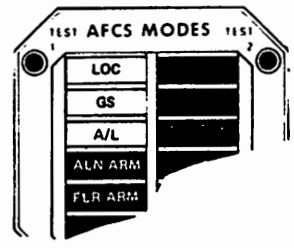
To change from A/L ARM to the track mode the requirements are:

i 1500R or below

ii the aircraft has captured the glideslope and has been established on it for at least 30 seconds.

A/L Track

At A/L track, assuming all Systems normal, the following changes take place:



i The autopilot channels become Dual-Dual, giving four channels of computation which are constantly compared.

ii The system becomes "fail operational" and any single failure will not disengage both autopilots.

iii Yaw dampers go to the "parallel" mode with rudder movement producing rudder pedal displacement. The damping authority is increased from 8° to 30°.

iv A/L can now only be disengaged by disconnecting APFDS or selecting Go-Around.

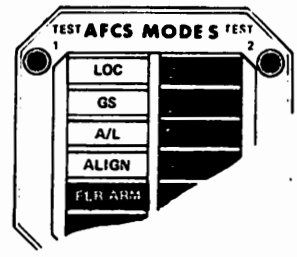
ALN ARM

Indicates that one or both Yaw damper systems are engaged and serviceable.

The system will change to ALIGN at 150R and correct for existing drift.

ALIGN

At 150R a combination of roll and Yaw input induces limited forward slip and removes the existing crab angle. The bank attitude will be held until 5R when there is a wings level command.



Bank limit becomes 5°.

ALIGN (Cont)

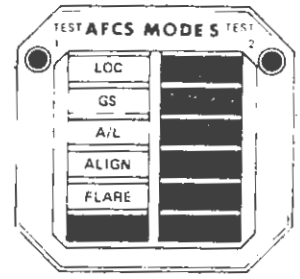
Correct alignment is dependent on the course selectors being set to the QDM.

FLR ARM

Indicates that inputs for the flare computation are valid.

FLARE

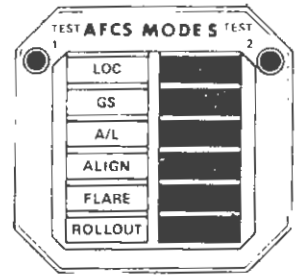
This is initiated at 50R when glideslope control is discarded and the computed flare law controls the aircraft in pitch until touchdown.



With auto throttle engaged the throttles will now close at a controlled rate towards idle but remain engaged until touchdown. Auto throttle is dealt with on Page 44.

ROLLOUT

This occurs at 5R when a wings level signal controls bank attitude. Yaw computer inputs to the rudder control the aircraft on the localiser centre line.



Touchdown

At this point a nose down bias supplies a controlled nose down pitch rate and the throttles close at a faster rate and automatically disconnect.

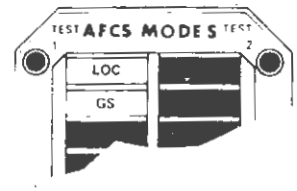
Limited nosewheel steering controlled from the Yaw computers will assist in holding the localiser centre line.

Note

An autopilot must remain engaged for automatic rollout control to be effective through the landing run.

FD - A/L MODE

As previously stated, this selection with autopilots not at CMD will provide a more reliable and accurate command system than engaging the APR mode.

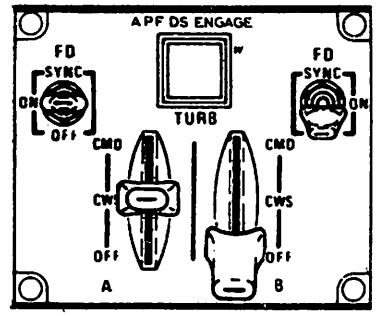


Mode displays are limited to LOC and GS but the system uses the associated A/L computers.

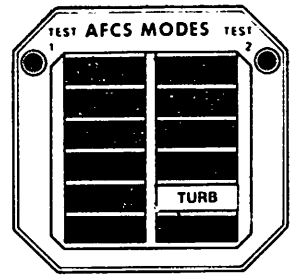
ALIGN and FLARE functions are not available. At 50R the command bars will bias out of view and will remain there until the mode is released.

TURBULENCE Mode

This switch light is only effective with an autopilot engaged.



When pressed it will:



i drop the engaged AP to CWS. If A/L is armed it will disengage the second engaged AP and drop the first to CWS.

ii bias both flight directors out of view.

iii disengage all modes excluding GO ARND and A/L if glideslope capture and tracking has taken place (TURB is not effective at A/L track and GO AROUND). Prevents engagement of any mode.

iv require double the normal force to overcome the basic attitude hold mode in CWS.

v when control wheel steering is used the autopilot response rates will be halved.

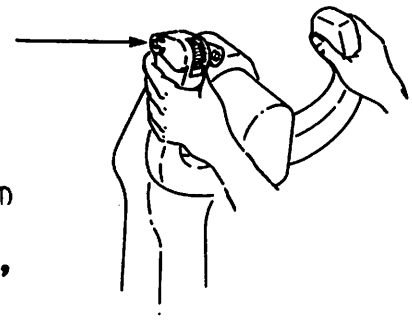
TURB Disengagement

This is only possible by either pressing the TURB switch light a second time or disengaging the autopilot.

The command bars will return to centre and modes can be reselected.

Take Off/Go Around Push button

This is located on each control wheel on the outboard horn.



Pressing the button will put the systems to a TAKE-OFF or GO AROUND mode dependent on a 'ground' or "flight" condition, AP engagement, FDs ON/off, flap settings.

GO-AROUND

With an autopilot engaged at CMD, pressing the TOGA switch is only effective with flap more than 30°.

Auto Go Around

i all existing modes, other than TURB, will disengage

ii if both autopilots were engaged then the second engaged AP will disengage

iii the auto throttle system will disconnect

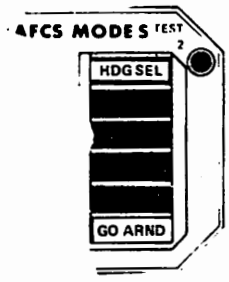
iv Yaw SAS will go to the parallel mode with greater authority for rudder control

v Speed is controlled through the ALPHA system to maintain 1.25 VS by pitch attitude. Throttles must be adjusted manually for Go-Around power. Maximum pitch demand will be $17\frac{1}{2}^{o}$.

vi A 'wings level' term replaces previous bank commands

vii D.L.C. is retracted.

HDG with TO.GA pressed



HDG SEL is compatible with Go-Around or take-off modes and is recommended for better heading control.

FD only with TO.GA pressed

With autopilots out of CMD and TURB not engaged the flight directors will command pitch and roll response through the command bars as in (V) and (V1) in auto Go-Around. HDG SEL is again recommended for heading control.

Yaw SAS is not changed to the parallel mode.

Auto throttle will disconnect and DLC retract.

A flap input is not necessary for Go-Around and the directors will command Go-Around responses if pressed in cruise or approach conditions.

Disengagement of Go-Around

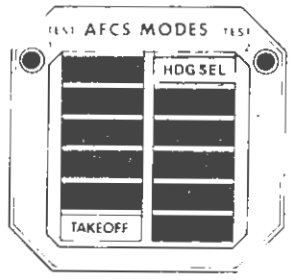
Engagement of one of the pitch modes will disengage Go-Around and revert the system to normal pitch control.

GO ARND inhibits TURB engagement.

Take-off Mode

This is a flight director mode and pressing the TOGA switch on the ground with an autopilot in CMD will not engage TAKE-OFF.

Engagement is possible with one or both flight directors ON and an autopilot at CWS.



The commands are similar to Go-Around. Pitch up demands are related to ALPHA PROBE position and will command a 1.25 VS during the climb. Roll demand is for 'wings level' but HDG SEL is recommended with runway heading set.

Max pitch up demand will be $17\frac{1}{2}^{\circ}$.

TOGA Push

In addition to controlling the APFD as above, the switch is also used to unshutter the Para Visual Directors for take-off guidance. This is dealt with on page 42.

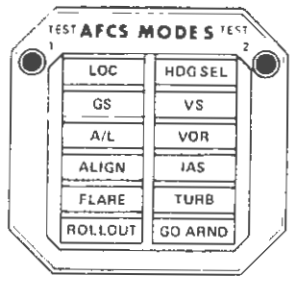
AFCS MODES TEST

Each mode indicator has a TEST 1 and TEST 2 push button. When a button is pressed both indicators display the same annunciators.

In addition certain mode switchlights will illuminate when the associated switch is pressed.

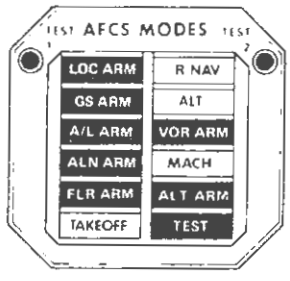
Press TEST 1.

Switchlights VS, IAS, HDG and TURB illuminate.



Press TEST 2

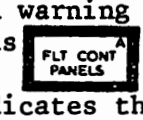
Switchlights ALT, MACH, and ALT ARM are lit.



MWS Caution

This warning is armed when an autopilot is engaged (CWS or CMD) and the system is not in A/L TRACK.

All input, control sources, computers and equipment validities that will be used at A/L track, are monitored throughout the flight.

A DANA warning may be accompanied by other MWS indications such as 

for a Yaw SAS failure.

It indicates that there is not a CAT 3 DUAL-DUAL Capability although a CAT 2 auto landing could be possible.

DANA Latch

The DUAL A/L NOT AVAIL warning is latched into the MWS at any time it is initiated.

If the initiating fault is cleared the DANA latch will be released:

a before A/L track, if the AP's are disconnected

b After A/L track by engineering reset.

DANA Inhibit

Below A/L track the DANA MWS will not illuminate for new failures. Instead an A.F.C.S. NO DUAL will appear, see Page 40.

DANA Reinstate

If cancelled, the DANA will reinstate:

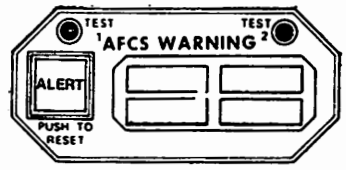
a When the second AP is engaged

b When the speed drops below 90 Kn or both AP's drop from CMD.

c During Auto Go Around.

AFCS WARNING Indicators

The warnings displayed are concerned with important aspects of autopilot and autoland reliability.



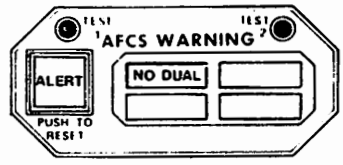
AFCS ALERT

At any time a warning is annunciated both ALERT lights will flash. These can be cancelled by pressing either ALERT light once. Pressing a second time will cancel all displayed warnings except NO DUAL.

NO DUAL

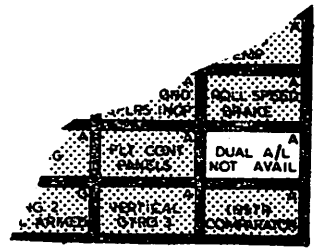
Armed at A/L track, this warning will appear if:

i the second autopilot is not engaged. When it is selected NO DUAL will clear.



NO DUAL (Cont)

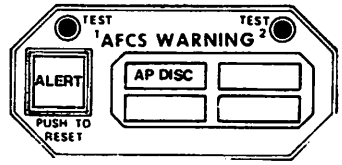
ii any malfunction that will reduce the DUAL-DUAL capability when a further like failure could cause full AP disconnect. This warning cannot be cancelled except by releasing the A/L MODE.



The warning is inhibited below 150R but a failure warning would appear in the DANA MWS when below 90 kts, or during Auto Go Around.

AP DISCONNECT

Armed when either autopilot is engaged, warning appears when both APs are disconnected by any means.

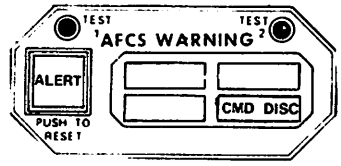


Will be accompanied by 2 second aural "wailer".

Warning displays can also be cleared by pressing an AP disconnect switch.

CMD DISCONNECT

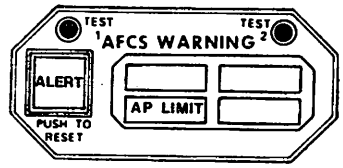
Armed at any time an autopilot lever is at CMD. Warning will occur when lever drops to CWS.



Likely causes, ADC failure, NAV receiver failure or selecting an incompatible frequency for the mode.

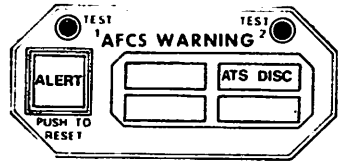
AP LIMIT

Indicates that the autopilot authority pitch force limits have been reached. The limits are doubled at A/L track.



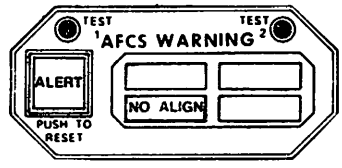
ATS DISCONNECT

The auto throttle system has disconnected. This warning will be annunciated when the ATS is disconnected by normal methods or through failure. The exceptions are after an autoland when the throttles close and disconnect as a function of the A/L sequence and GO ARND.



NO ALIGN

This is a normal indication in LOC or APR modes with the autopilot and/or FDs engaged or at A/L with only flight directors engaged.



The warning appears at LOC track.

NO ALIGN (Cont)

If the warning is cancelled it will re-annunciate at 150R when NO FLARE also appears.

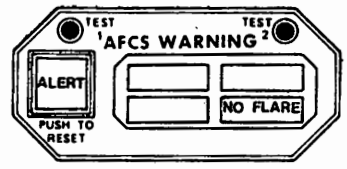
During an automatic landing it will indicate :

i The course selectors differ by more than 6° after LOC track.

ii If both Yaw dampers have failed or inputs to their computers are invalid for alignment after A/L track.

NO FLARE

This is a normal indication in the APR mode or a flight director only A/L mode. It will appear at 150R and reinstate NO ALIGN at the same time.

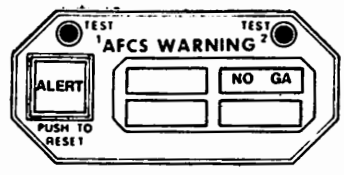


During an automatic landing it will indicate after A/L track if flare computing is invalid.

NO GO AROUND

The warning is armed at glideslope capture.

It indicates that go around computing is invalid.

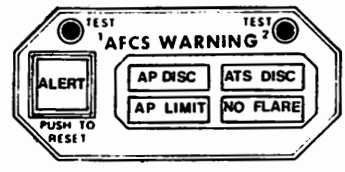


AFCS WARNING TEST

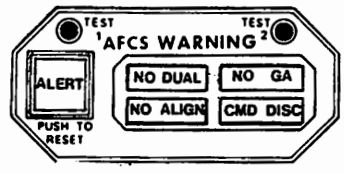
Each indicator tests its own displays through the two TEST switches but there is partial crossover to the other display and both ALERT lights flash.

TEST 1

Plus opposite AP LIMIT and NO FLARE



TEST 2
Plus opposite NO DUAL, NO ALIGN and CMD DISC



ILS DEVIATION WARNING

This is armed at AL track and the lights will flash for excessive localiser or glideslope deviation.

The flashing will stop when the deviation decreases.

Glideslope deviation warning is inhibited at the FLARE phase and localiser warning at ROLL OUT.

The autopilot will not follow excessive and high rates of deviation. If excessive deviation persists the autopilot will disconnect.

Abnormal Management

See Flight Management/FAIL

PARAVISUAL DIRECTORS

GENERAL

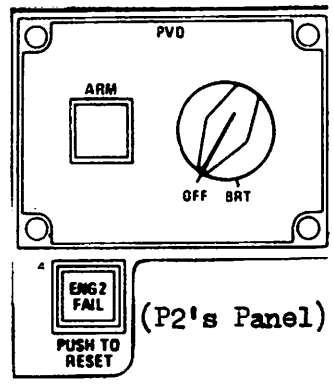
The function of the PVD displays is to provide reversionary centre line guidance on the ground during take-off in CAT 3 conditions and to provide similar guidance after landing if ROLL OUT alignment is not available.

CONTROLS AND INDICATORS

ARM Switch

This is a latching switch that arms the PVD to operate when "weight-on" through the take-off or landing logic control. It must also be selected for OVRD control.

When armed the switchlight is illuminated.



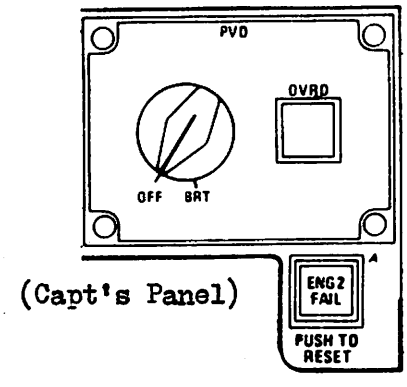
OVRD Switch

A latching switch that will override the normal shutter control.

The ARM switch must be lit for OVRD operation.

It will enable the display lighting to be adjusted in advance.

The switchlight illuminates when OVRD is selected.



PVD Displays

These consist of a rotating rod with helical markings. Dependent on the direction of rotation the diamonds appear to stream to left or right when not on the centreline - these are demand indications, turning in the direction of streaming will slow and stop the movement.

The displays are completely shuttered when not in use - and will also shutter if the system is invalid.

MWS Caution

This warning is armed when the PVD is armed and will indicate if there is a failure of the computer or the Yaw rate gyro.

Invalid radio inputs from NAV 2 will operate the MWS with the landing gear down and an ILS frequency tuned.

Operation of PVD Shutter

For the shutters to open normally the aircraft must be weight-on, NAV 2 tuned to a valid ILS frequency with a serviceable PVD plus:-

i Flap at 33° or 42°, with both APs disengaged or a NO ALIGN warning.

or

ii Flap in the take-off range and the Take-off Go Around button pressed.

If the flight directors are not switched on the TAKE-OFF mode will not annunciate when the TOGA switch is pressed.

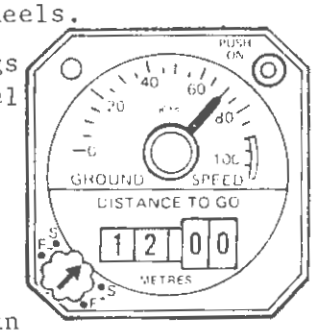
Abnormal Management

See Flight Management/FAIL.

GROUND RUN MONITOR

GENERAL

The instrument indications are controlled by sensors in the rear outboard main wheels.



Ground speed and distance to go readings are controlled by the first sensor wheel to rotate. Distance to go will reduce with rotation until the counters indicate zero.

In flight a 10 kn inhibit prevents DTG reduction with wheel rotation.

On the ground, if speed falls below 5 kn the speed pointer will pulse up every quarter revolution of the turning wheel.

Setting knob

Spring loaded back to normal, when rotated to Fast + or - Speed indicates in the green sector and counters increase / decrease at a fast rate.

At Slow + or - counter rate is reduced and the speed pointer remains at zero.

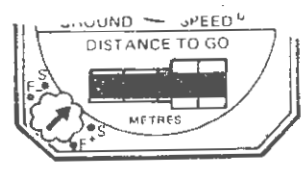
Amber lamp

Illuminates with a large difference between wheel speed sensors or when setting knob operated.

The warning is delayed for seven seconds after initial rotation.

PUSH ON knob

When pulled inhibits the DISTANCE TO GO counter.



Fail flag

This shows with power failure or if the inhibit knob is pulled

SPEED CONTROL SYSTEM AND AUTO THROTTLE

GENERAL

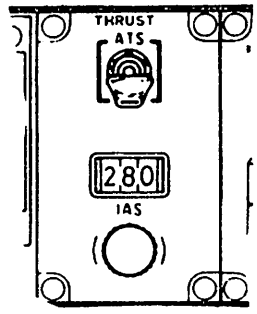
The speed control system consists of a speed computer with inputs from the Air Data Computers, Alpha probes, radio altimeters and flight control parameters.

The SCS computer controls the ADI speed pointers, the auto throttle system and Alpha inputs for Go around.

THRUST PANEL

IAS Counter and Setting Knob

The counter is set to the required airspeed by the setting knob.



This provides a datum speed command for the fast/slow pointers on the ADIs and auto throttle when operating above the stall margin.

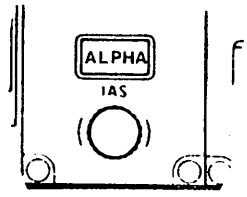
ALPHA Flag

The flag covers the IAS counter and modifies the datum when:

i the speed is $1.3V_S$ or less and the alpha probes are sensing correct angle of attack.

ii Flaps are greater than 30° when the speed demands are related to $1.3V_S$.

iii Take-off or Go around has been initiated when the command speed datum will be $1.25\ V_S$.

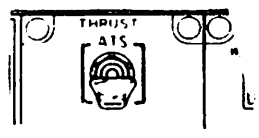


NOTE

The IAS counter reading has no control over the IAS pitch mode of operation.

ATS Switch

A solenoid held engagement switch for the auto throttle system.



The switch only holds at the ATS position if the system is Valid and not "Weight On".

THRUST PANEL

ATS Switch (Cont)

The ATS will disengage automatically if:

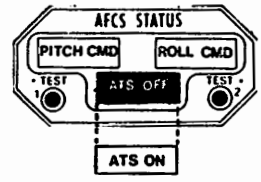
i An autoland has been made

ii the Take Off - Go Around switch is pressed

iii TURB, ASI, or MACH modes are engaged.

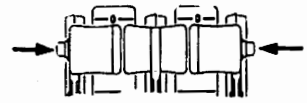
Auto Throttle Engagement Indications

The AFCS Status indicators show the ATS status as OFF or ON.



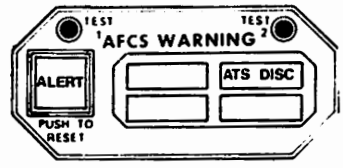
Auto Throttle Disconnect Switches

Located on 1 & 3 throttles, when pressed disengage the auto throttle system.



Auto Throttle Disconnect Warning

The AFCS warning indications show for all methods of ATS disconnect except those following an auto land or through pressing the TOGA switch.

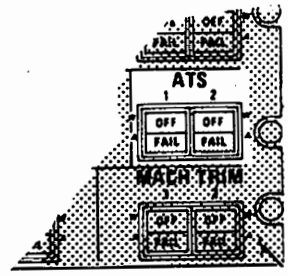


ATS Control Switches

The two switches control auto throttle systems 1 and 2 respectively. The switches are of the latching type.

Latched in and Dark

No 1 system controls the auto throttle servo motor and comparison monitoring exist between the two systems.



(Flight Controls) panel

OFF

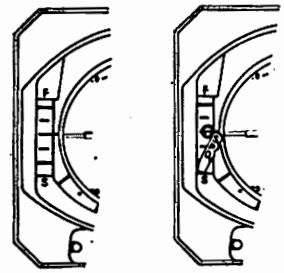
The switch has been released, the associated system is inhibited and, if Nr 1, Nr 2 can now control the servo.

FAIL

Will appear with power failure or invalid signals. With both switches latched IN, a single system fault will normally bring on FAIL in both switchlights.

It will be necessary to cycle both switches OFF then relatch independently to select a serviceable system for auto throttle control.

The fast/slow indicator will bias out of view with invalid signals or its flag will appear with power failure.



MWS Caution

This will illuminate with a FAIL indication in the switchlights.

Auto Throttle Operation

A single servo motor is used to drive all three throttles. Control is normally through Nr 1 ATS system.

The range of auto throttle operation is between maximum and minimum limit switches which prevent the throttles driving fully open or fully closed in flight.

Throttles can be manually adjusted for trimming with auto throttle engaged.

The system will maintain the IAS set or the Alpha Speed until the FLARE phase of an autoland. The throttles then start to close at a controlled rate.

They finally fully close and automatically disconnect after touchdown.

Gust Compensation

Operates in the Alpha mode to increase the datum speed by increments of 4 and 8 knots for short term gusts exceeding 8 and 16 knots.

YAW STABILITY AUGMENTATION SYSTEM

GENERAL

The YAW SAS consists of two channels giving dual-dual capability similar to the autopilots and satisfies category 3 requirements.

Its basic function is to correct any "dutch roll" tendencies.

With the autopilot engaged it will also provide:

a turn compensation during "cruise" modes

b drift correction below 150 feet in an automatic landing

c roll out control on the runway after an automatic landing.

OPERATING MODES

The YAW SAS system operates in two modes, SERIES and PARALLEL.

Series

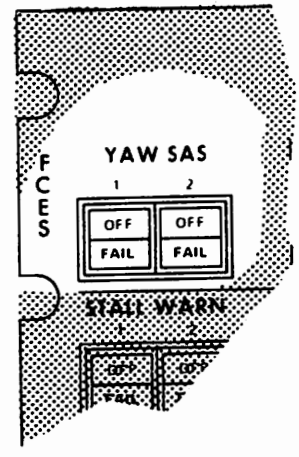
The correcting inputs control the rudder without any feed back through the rudder pedals. Its authority is limited to $\pm 8^{o}$. This is the mode of operation in manual flight and through all autopilot "cruise" modes.

Parallel

Yaw control provides feed back through the rudder pedals. Its authority is increased to $\pm 30^{o}$. This mode is only effective from A/L track to Roll Out and during Automatic Go Around.

CONTROLS AND INDICATORS

YAW SAS 1 & 2 switchlights are located in the roof panel. They are the latching type.



Normal Operation

Both switches are latched in and dark.

OFF

Switch is released and associated YAW SAS is disengaged.

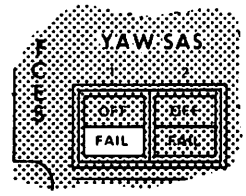
FAIL

Invalid control signals or failed electrical or hydraulic supplies with the switch latched in.

With failure it may be necessary to cycle the switch to clear a FAIL indication following corrective action.

MWS Caution

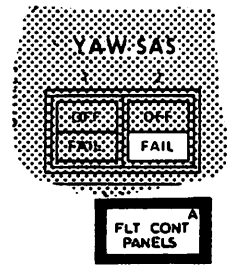
With FAIL illuminated.



OPERATION

Yaw rate gyro's supply inputs to the two YAW SAS systems. Either YAW SAS unit can provide YAW damping, Alignment and Roll Out functions. Inputs from the Course Selectors are used for ALIGN below 150 ft. Localiser signals provide ROLL OUT control.

WARNINGS



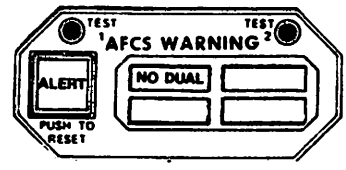
Single YAW SAS

With both switches latched in and an invalid input there will be an MWS warning and FAIL illuminated.

Single YAW SAS OFF or FAIL

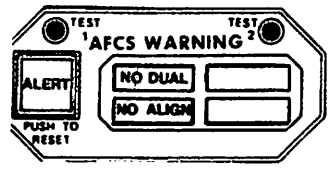
If the autopilot system is engaged (at CWS or CMD) there will be a MWS indication prior to A/L track.

If the above occurs, at A/L track there will be an AFCS warning.



Both YAW SAS OFF or FAILED

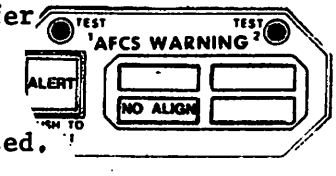
With A/L mode engaged the ALN ARM and ALIGN modes will not annunciate. At A/L track there will be AFCS warnings.



The ALERT lights and NO ALIGN can be cancelled but not NO DUAL.

COURSE SELECTORS Differ

With A/L mode engaged there will be an AFCS warning if they differ by more than 6° at LOC track.



This warning will clear if the Course Selectors are synchronised.

With an excessive discrepancy at 150R both YAW SAS will fail with loss of ALIGN and ROLL OUT control.

POWER SOURCES

Electrical

	Ess Bus AC	Ess Bus DC	Bus 1 AC	Bus 1 DC	Bus 2 AC	Bus 2 DC	Bus 3 DC
APFDS	A	A			B	B	
YAW SAS	1				2		
Yaw Rate Gyros	1		3		2		
AFCS Mode/Status Inds.		L				R	
AFCS Warn Inds.						L	R
SCS	L				R		
ATS	1	1&2			2		
Pitch Trim	1	1			2	2	
PVD					*	*	
GRM					*		

Hydraulic

	HYD A	HYD B
Autopilots	B	A
YAW SAS	2	1

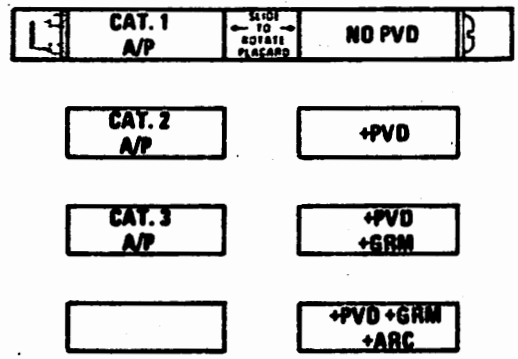
PLACARDS and LABELS

GENERAL

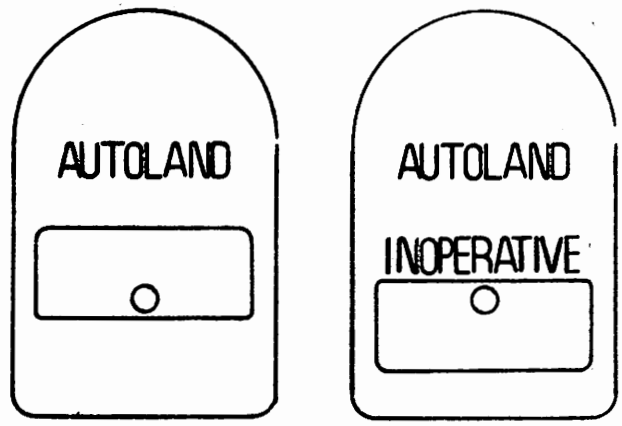
Placards as illustrated are located on the centre instrument panel and each control column.

Information related to placards is listed in Flight Management/FAIL.

Centre Instrument Panel



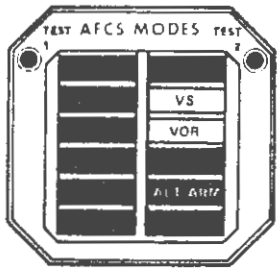
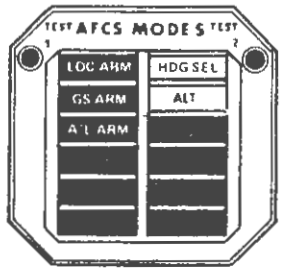
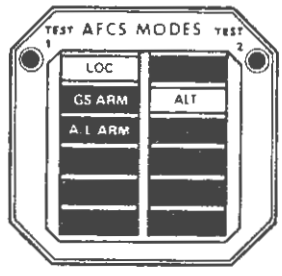
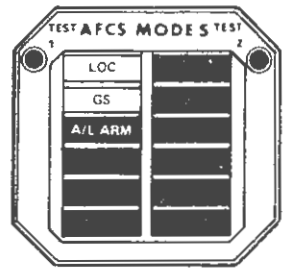
Control Columns



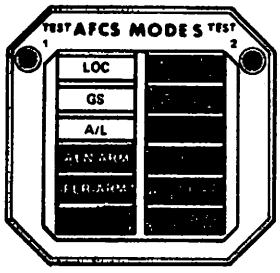
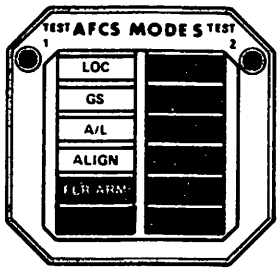
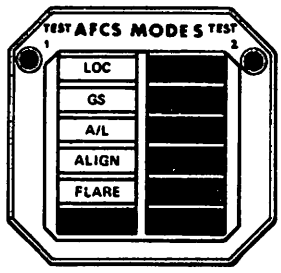
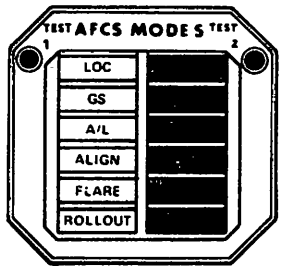
PICTORIAL SUMMARY OF WARNINGS

Pages 52 and 53 summarise possible AFCS indications and warnings that could occur through a flight sequence because of abnormal operating conditions.

APFDS WARNINGS AND INDICATIONS

CONDITION/ RADIO HEIGHT	CRUISE MODES	APPROACH/LAND ENGAGED AUTOTHROTTLE ENGAGED	LOCALISER CAPTURE 2ND AP ENGAGED	GLIDESLOPE CAPTURE DLC FUNCTIONS WITH FLAP AT 33 OR 42
POSSIBLE MODE INDICATIONS				
POSSIBLE AFCS WARNINGS 	AT ANYTIME AN AUTOPILOT IS ENGAGED AP DISC — BOTH APs TO OFF PLUS AURAL WARNING CMD DISC — INVALID CMD AP DROPS TO CWS AP LIMIT — EXCESSIVE LOAD IN PITCH CHANGE	ATS DISC — AT ANYTIME AUTOTHROTTLE DISCONNECTS EXCEPT AFTER LANDING OR DURING AN AUTO GO AROUND	NO ALIGN — IF THE COURSE SELECTORS DIFFER OR THE COMPASSES DISAGREE NOTE THIS WARNING WILL ALSO APPEAR DURING: A AN FD APPROACH/ LAND SEQUENCE B AN AP OR FD APR MODE SEQUENCE	NO GA — IF THE GO AROUND COMPUTING IS INVALID.
POSSIBLE MASTER WARNING SYSTEM DISPLAYS	DUAL A/L NOT AVAIL — APPEARS WITH AUTOLAND COMPONENT FAILURE WHEN AN AP IS AT CWS OR CMD. FLT CONT PANELS — IF EITHER PITCH TRIM SWITCH-LIGHT SHOWS OFF OR FAIL HYDRAULIC SYSTEM — IF A OR B HYD SYSTEMS FAIL ESS/STBY POWER — IF AC S/BY OR AC ESS FAIL ELECTRICAL SYSTEM — IF AC BUS 2 FAILS	FLT CONT PANELS — IF ATS SWITCHLIGHT SHOWS FAIL	DUAL A/L NOT AVAIL — WILL REINSTATE IF PREVIOUSLY CANCELLED WHEN 2ND AP ENGAGED.	FLT CONT PANELS — IF ATS SWITCH-LIGHT SHOWS FAIL

APFDS WARNINGS AND INDICATIONS (Cont'd)

GLIDESLOPE TRACKED FOR 30 SECS AND RADIO HEIGHT 1500 FT OR LESS AIRCRAFT NOW HAS DUAL-DUAL AP OPERATION	150 FT R DRIFT REMOVED AND A/C ALIGNS THROUGH YAW SAS	50 FT R FLARE STARTS. GLIDESLOPE NOT CONTROLLING. THROTTLES START TO CLOSE.	5 FT R ALIGN CONTROL REPLACED BY ROLLOUT CONTROL. THROTTLES CLOSE AND DISENGAGE ON TOUCH DOWN.
			
ILS DEVIATION — LIGHTS FLASH FOR DEVIATION FROM LOCALISER OR GLIDESLOPE		ILS DEVIATION INHIBITED FOR GLIDESLOPE WARNING.	ILS DEVIATION WARNING INHIBITED.
NO DUAL — A IF 2ND AP NOT YET ENGAGED - WARNING CLEARS WHEN BOTH AT CMD. B IF AN AP A/L COMPONENT FAILS - WARNING CANNOT BE CLEARED. NO ALIGN — FAILURE OF BOTH YAW SAS FOR PARALLEL OPERATION NO FLARE — FAILURE OF FLARE COMPUTING	NO ALIGN — REINSTATES DURING APR OR FD A/L SEQUENCE. NO FLARE — INDICATES FOR APR OR FD A/L SEQUENCE NO DUAL — IS INHIBITED		PVD WILL UNSHUTTER ON TOUCHDOWN IF THERE IS NO ROLLOUT CONTROL
DUAL A/L NOT AVAIL A — WILL NOT OPERATE DURING A/L TRACK FLT CONT PANELS A — IF YAW SAS SWITCHLIGHTS SHOW FAIL.			DUAL A/L NOT AVAIL A — WILL APPEAR AFTER LANDING IF THERE IS A NO DUAL CONDITION WITHIN THE APFDS.

PICTORIAL FLIGHT PROFILE

The following illustrations show possible A.F.C.S. selections and resulting indications for a hypothetical flight from take-off at Mason Airport to an automatic landing at Dixon. The sequence is not concerned with abnormal procedures.

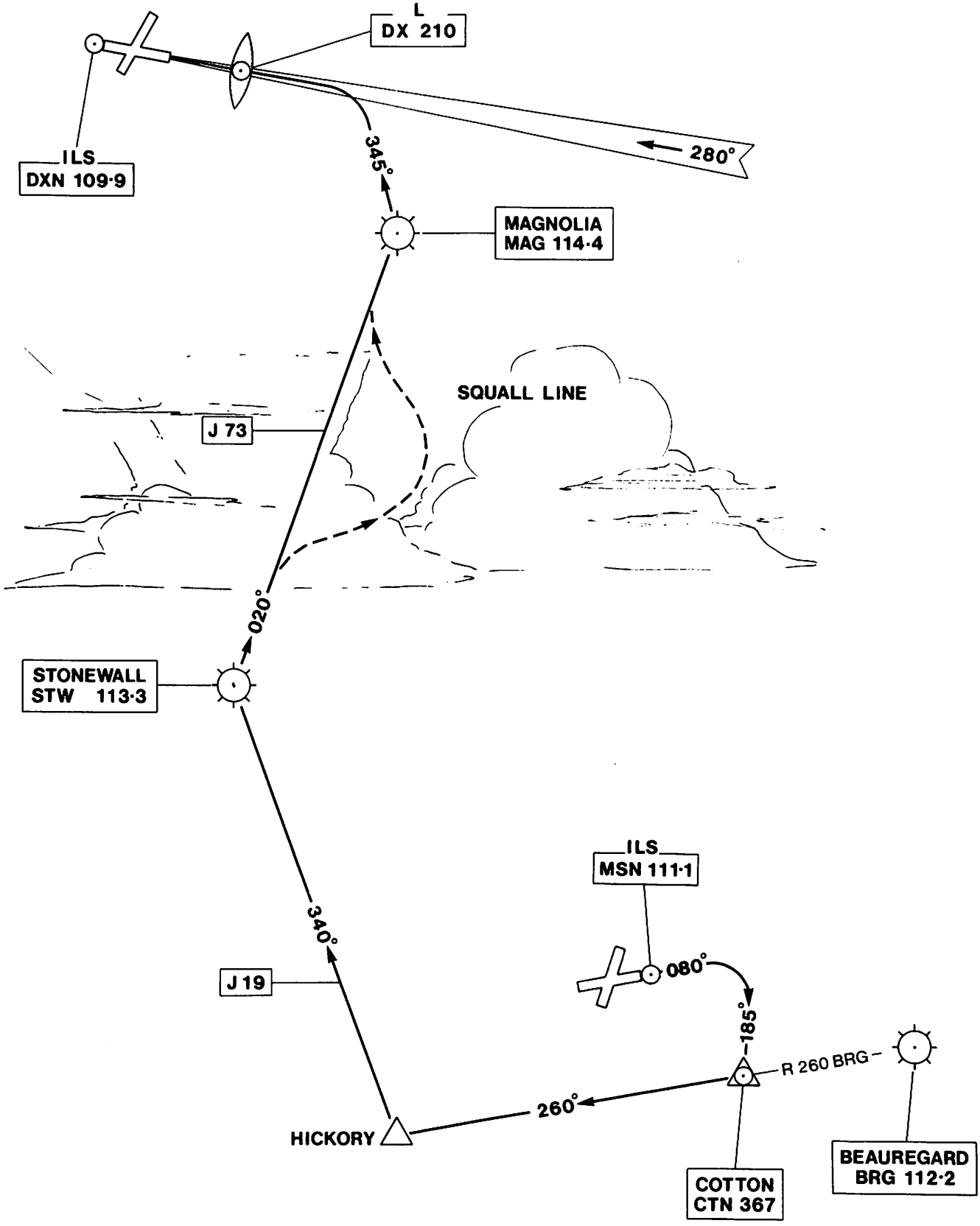
The steps in the illustrations are keyed to show:

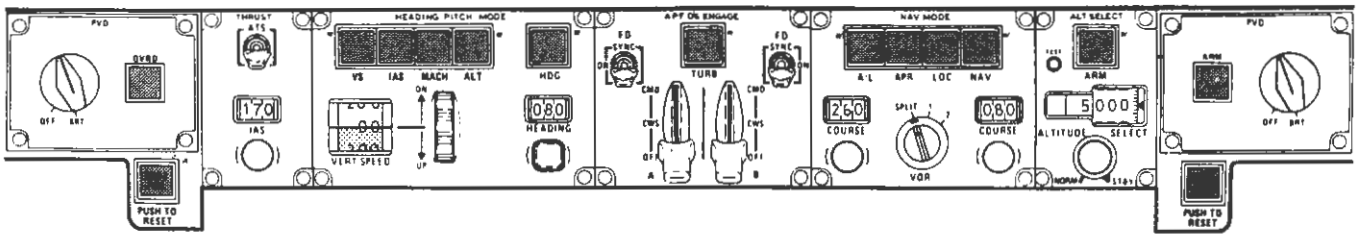
* * What you do
* ● What you see or what happens.

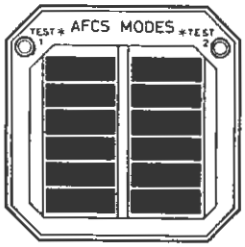
NOTE: For normal operational use of the A.F.C.S. see Volume 1 OPERATING STANDARDS - SYSTEMS MANAGEMENT.

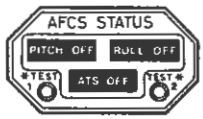
CATFISH ONE DEPARTURE (RWY 8)

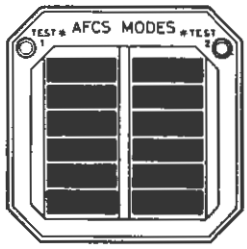
AFTER TAKEOFF TURN RIGHT AND CLIMB ON A HEADING OF 185° TO INTERSECT THE BEAUREGARD 260° RADIAL AT COTTON NDB. THENCE VIA THE BEAUREGARD 260° RADIAL TO THE HICKORY INTERSECTION. THENCE VIA THE STONEWALL 160° RADIAL. CROSS HICKORY INTERSECTION AT 5000 FEET. CLIMB ON COURSE AFTER LEAVING HICKORY.

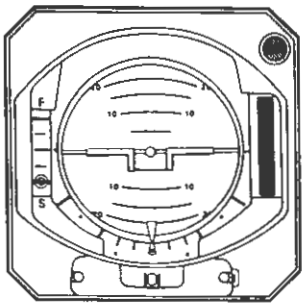

L
DX 210
ILS
DXN 109·9
280°
345°
MAGNOLIA
MAG 114·4
SQUALL LINE
J 73
020°
STONEWALL
STW 113·3
ILS
MSN 111·1
340°
080°
J 19
185°
R 260 BRG
260°
HICKORY
COTTON
CTN 367
BEAUREGARD
BRG 112·2









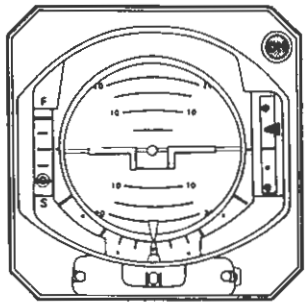


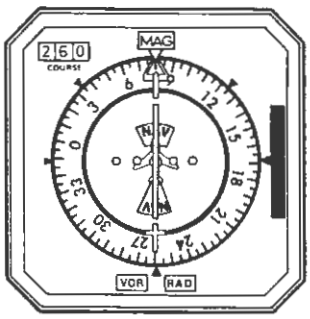
* No. 1 VHF NAV	-	TUNE DEP VOR
* No. 2 VHF NAV	-	TUNE MASON ILS
* No. 2 ADF	-	TUNE DEP NDB
* ADF/VOR SWITCHES	-	No. 1 VOR No. 2 ADF
* IAS SELECTOR	-	VNA
* HEADING SELECTOR	-	RWY HDG
* No. 1 COURSE SELECTOR	-	OUTBOUND RADIAL
* No. 2 COURSE SELECTOR	-	RWY QDM
* ALTITUDE SELECT	-	5000 FEET
● Radio Deviation	-	VOR - CPTNS HSI ILS - P2s HSI & ADI
● RMI Pointers	-	RED - BRG VOR GREEN - CTN NDB

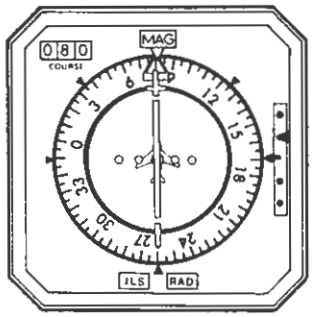
* VOR/DME SWITCHES TO STANDBY

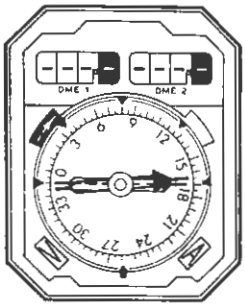
● No. 1 HSI deviation bar to centre - NAV fail shows.

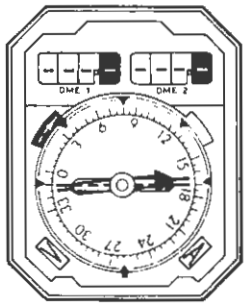
● RMI red pointer to 090 - Fail flag shows.

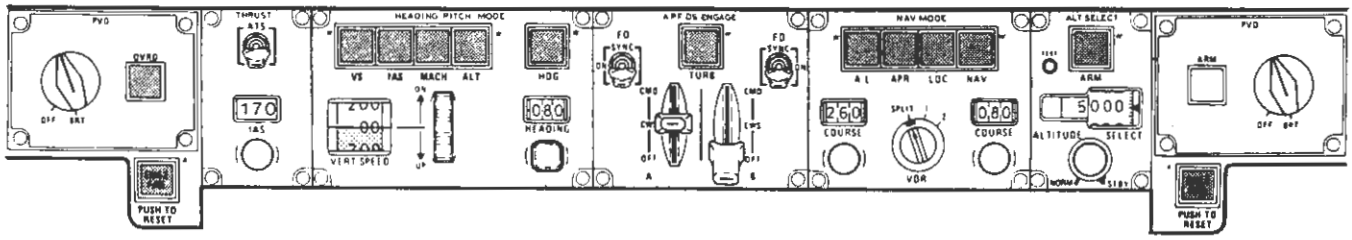


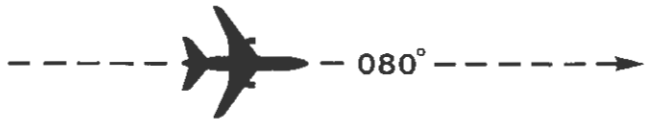


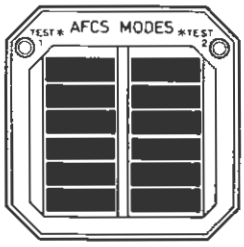


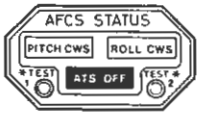


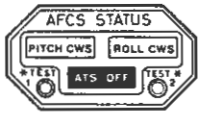












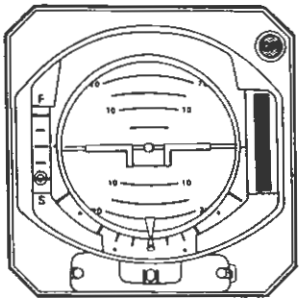
APPROACHING RUNWAY

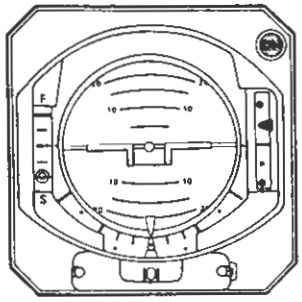
* AUTOPILOTS	-	OFF
or 'A' (or 'B')	-	CWS
* FLIGHT DIRECTORS	-	OFF

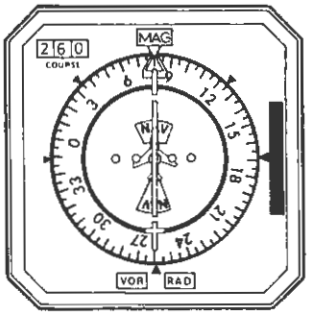
WHEN ENTERING RUNWAY

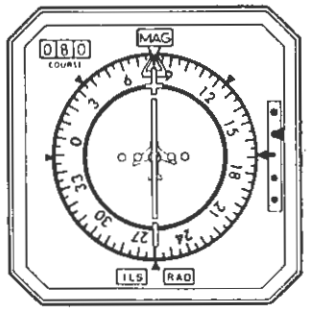
* PVD ARM SWITCH	-	PRESS
* TAKE OFF/GO AROUND SWITCH	-	PRESS (on control wheel)

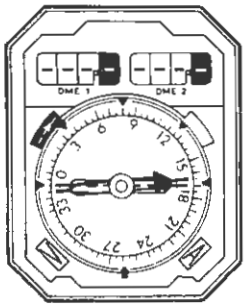
- AFCS status shows PITCH & ROLL CWS
- Mode annunciators - BLANK
- PVDs Unshutter and Stream to indicate localiser centreline.
- When positioned on runway centreline - PVDs stop streaming
- ADI FAST/SLOW pointers - SLOW
- VSI indicators zero

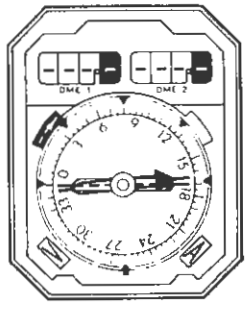


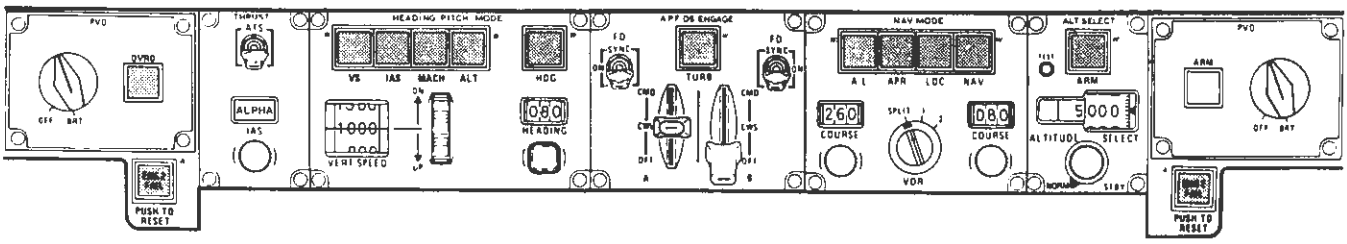


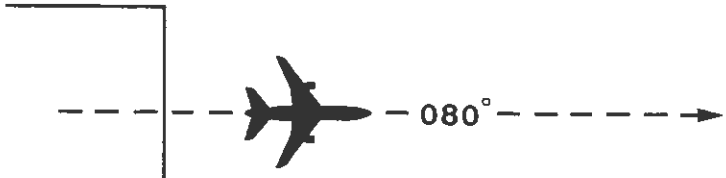


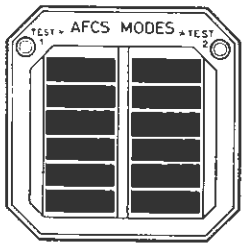


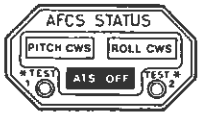


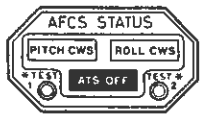


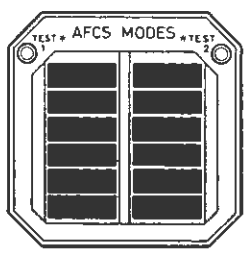








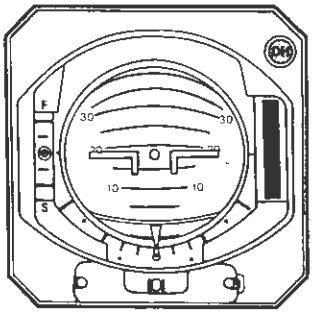


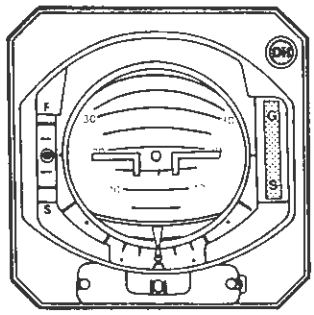


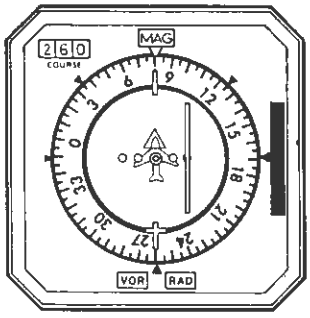
- As aircraft accelerates on runway the PVDs provide reversionary steering guidance in low visibility until airborne when shutters close. ALPHA flag covers IAS counter.
- FAST/SLOW Pointers indicate central when ALPHA speed command is satisfied.
- VS indicator shows rate of climb.

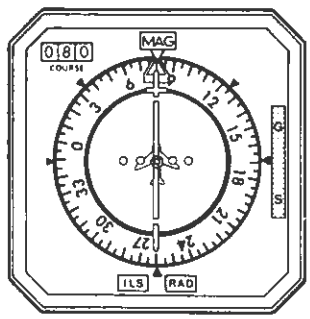
* VOR/DME SWITCHES - NORM

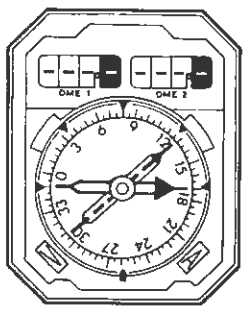
- Radio deviations and bearings are displayed on RSIs and RMIs.

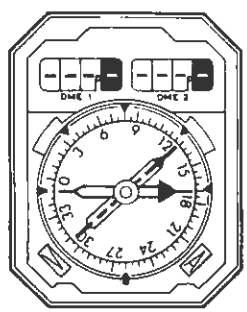


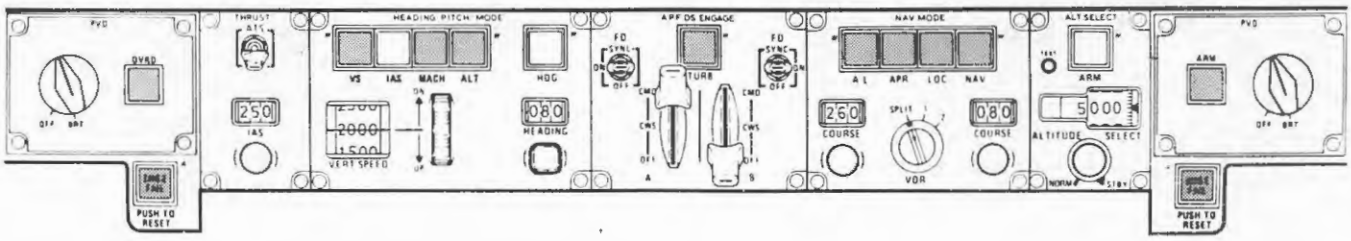


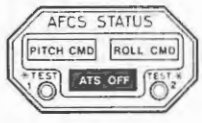


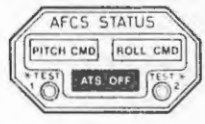


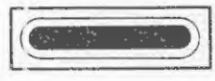


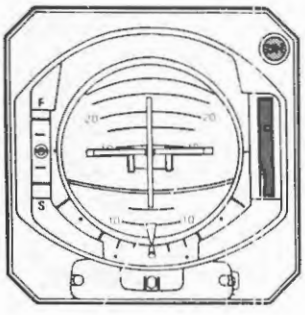


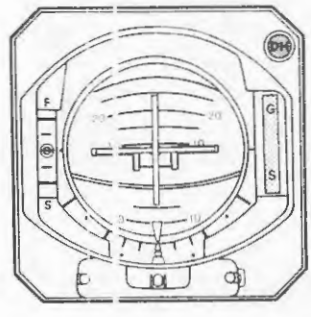












* RETRACT FLAPS ON SCHEDULE.

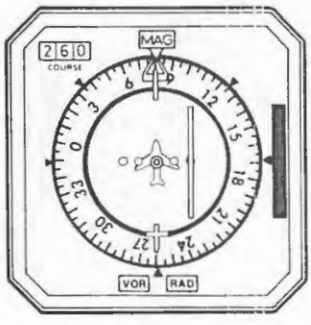
* MOVE ENGAGED AP LEVER TO CMD.

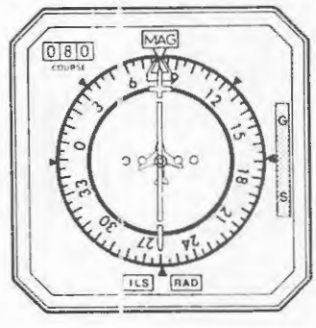
* SELECT FLIGHT DIRECTORS ON.

* AFTER REQUIRED CLIMB IAS IS ESTABLISHED PRESS IAS, HDG and ALT ARM SWITCHLIGHTS.

● AFCS status show PITCH CMD ROLL CMD.

* RELEASE PVD ARM SWITCHLIGHT - DARK.



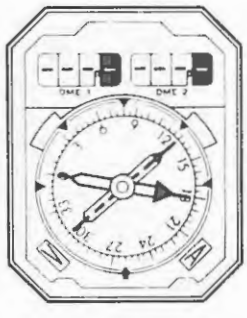


● Autopilot maintains existing air speed.

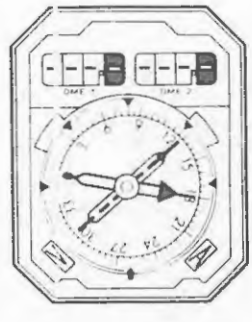
● ALPHA disappears from thrust panel.

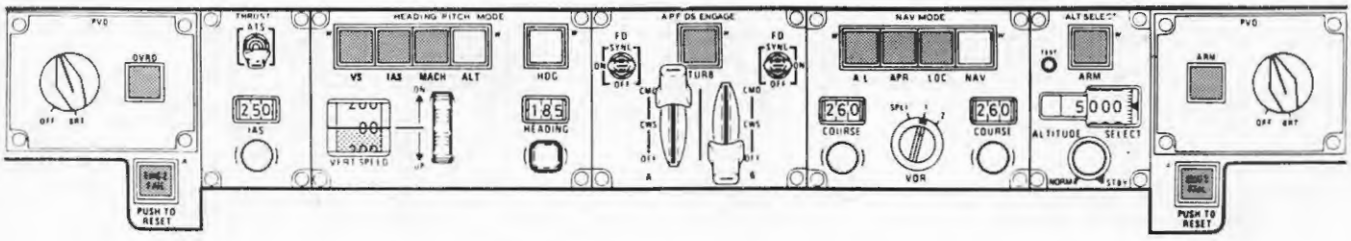
● Mode annunciators show HDG SEL, IAS and ALT ARM.

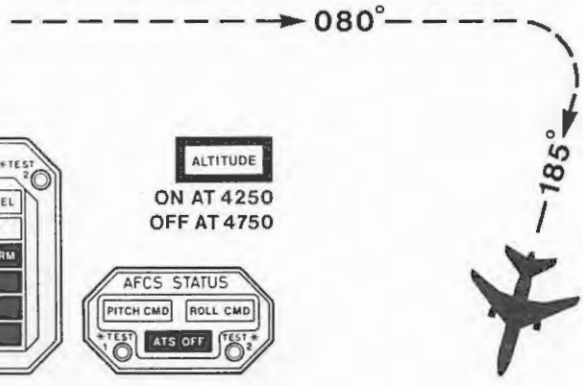
* SET CLIMB IAS ON THRUST PANEL.

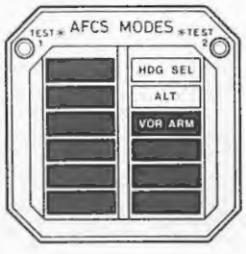


● SLOW/FAST ringsights central (if airspeed is that set in thrust panel)



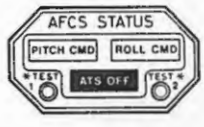


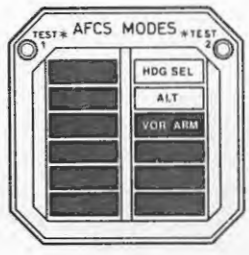


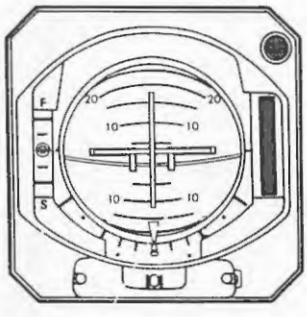


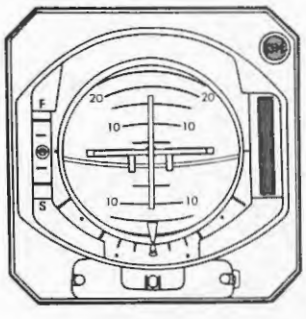
ALTITUDE
ON AT 4250
OFF AT 4750

ALTITUDE
ON AT 4250
OFF AT 4750









* SELECT NAV 2 TO BRG VOR FREQ.

* No. 2 COURSE SELECTOR TO VOR RADIAL.

* SELECT 185° ON HDG SEL.

● Aircraft turns on to 185°.

● RMI GREEN indicates on course to NDB.

● As aircraft climbs through 4250 amber ALTITUDE lights - lit.
At 4750 feet ALTITUDE lights - dark.
Aural warning operates.

● IAS switchlight dark - IAS mode clears.

● ALT ARM disappears and ALT appears on mode indicators.

● ALT illuminates on pitch mode panel.
ALT SELECT ARM light - dark.

* ADJUST THROTTLES FOR REQUIRED IAS.

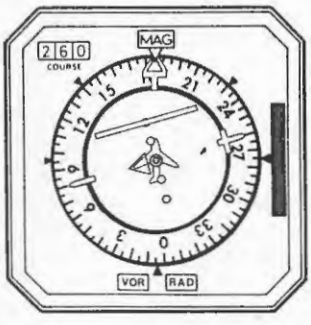
● SLOW/FAST indicators central when maintaining IAS set in thrust panel.

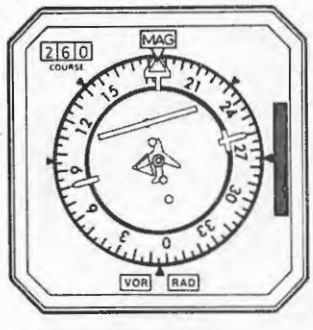
* PRESS NAV MODE SELECTOR.

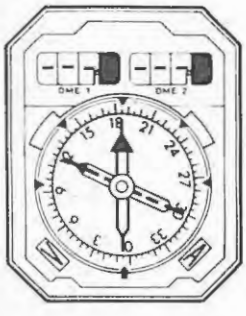
* SELECT VOR 1 ON NAV MODES PANEL.

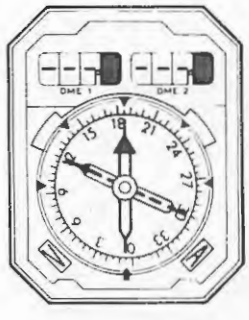
● NAV illuminates on NAV modes panel.

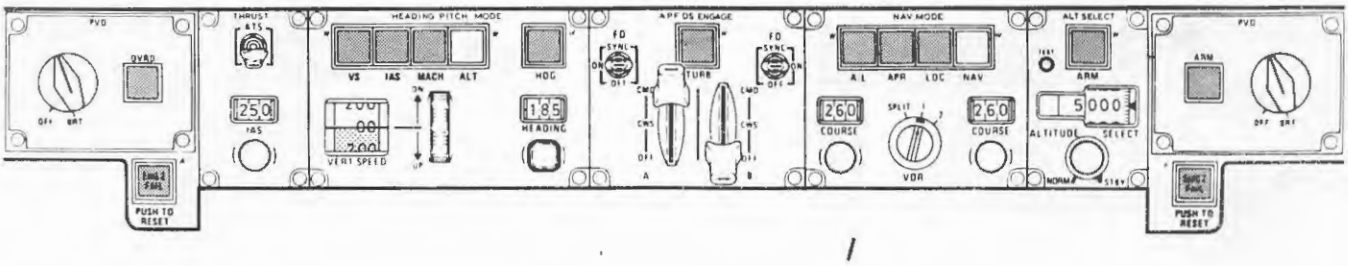
● VOR ARM appears on mode annunciator.

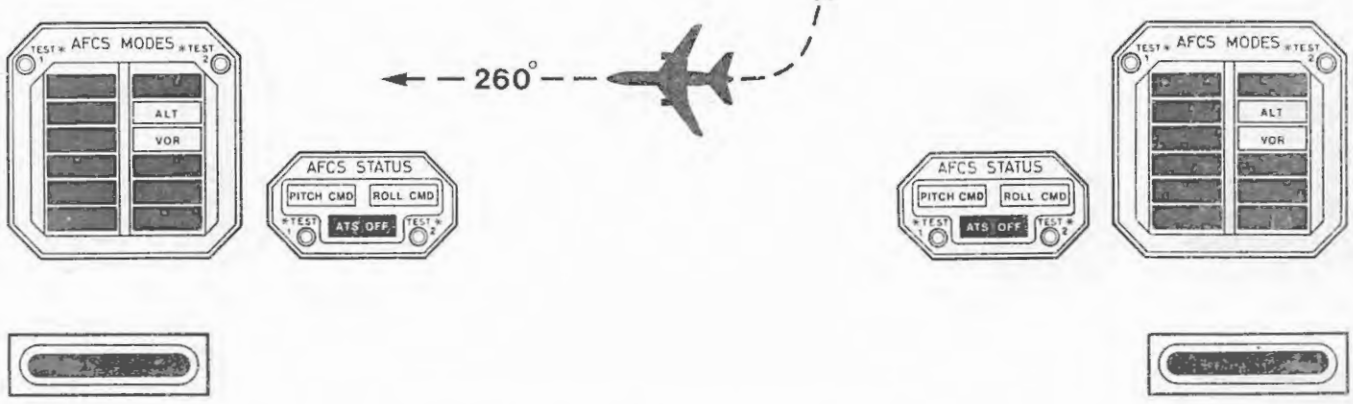








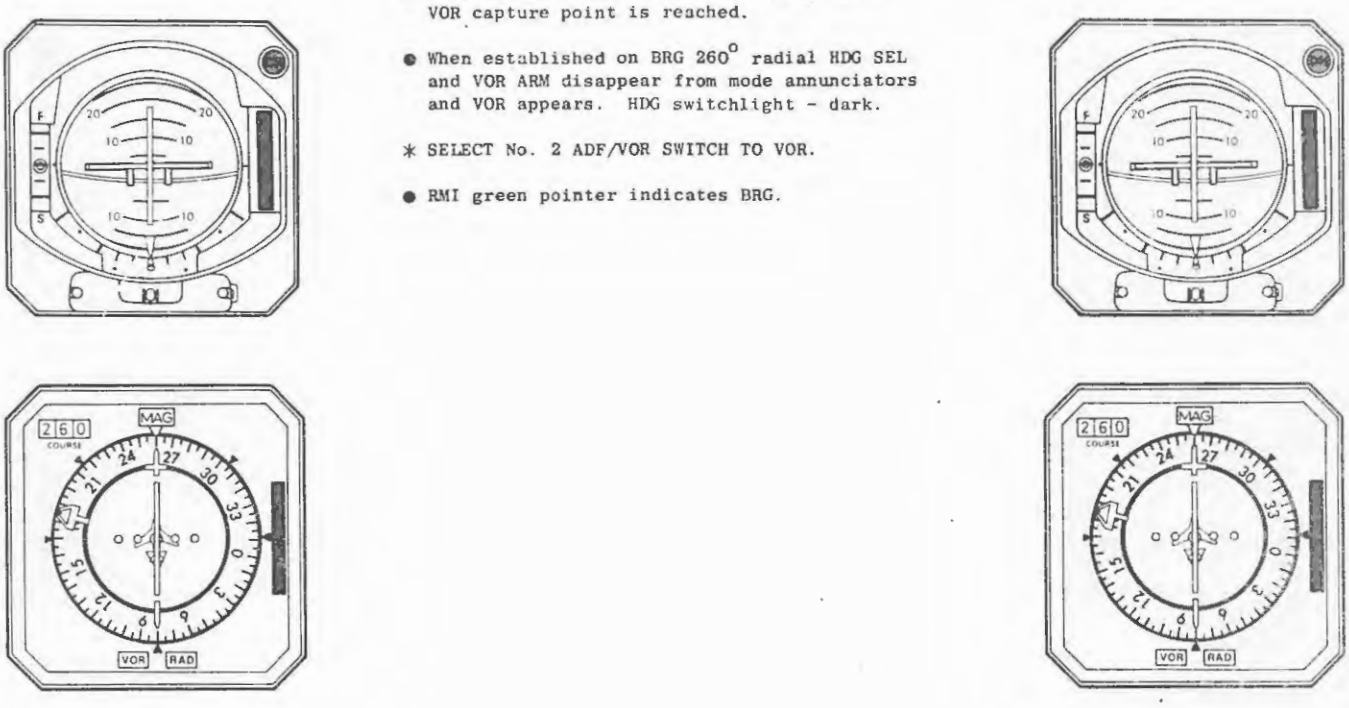


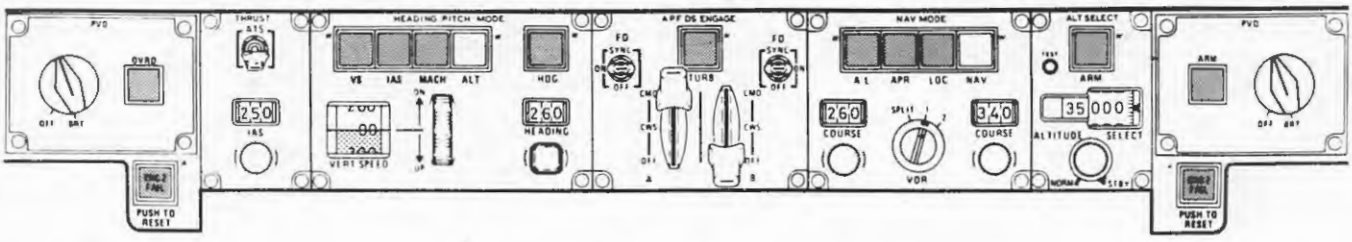


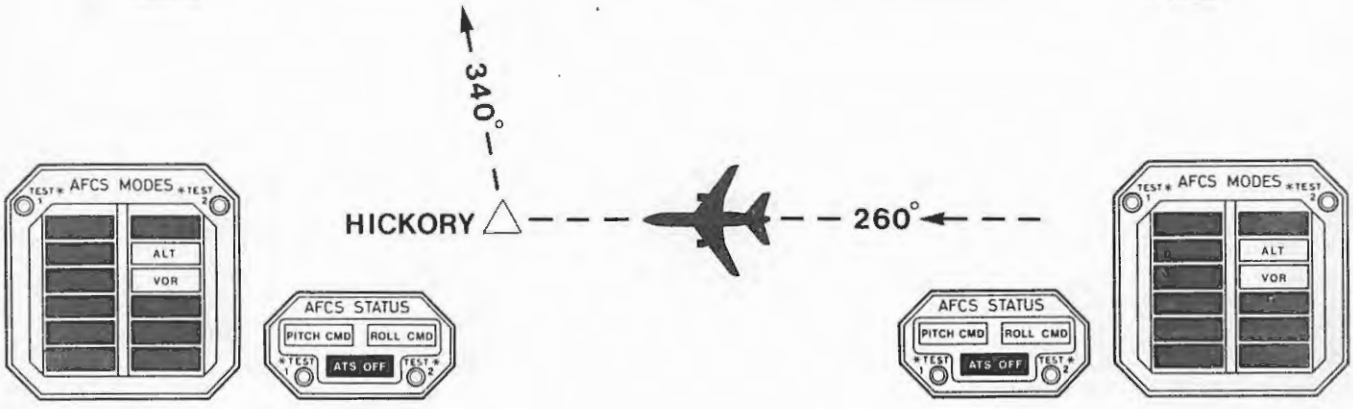
- Aircraft maintains selected heading until VOR capture point is reached.
- When established on BRG 260° radial HDG SEL and VOR ARM disappear from mode annunciators and VOR appears. HDG switchlight - dark.

* SELECT No. 2 ADF/VOR SWITCH TO VOR.

- RMI green pointer indicates BRG.







* SELECT 260° WITH HEADING CONTROL.

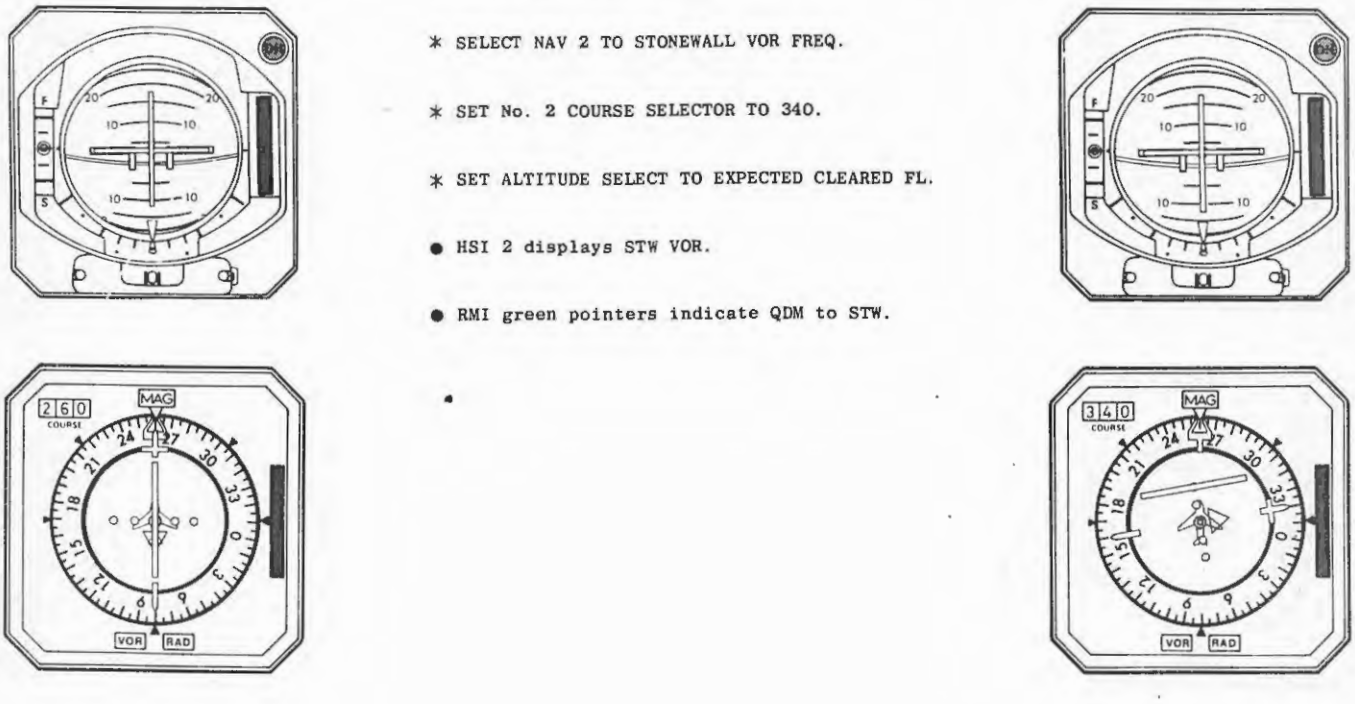
* SELECT NAV 2 TO STONEWALL VOR FREQ.

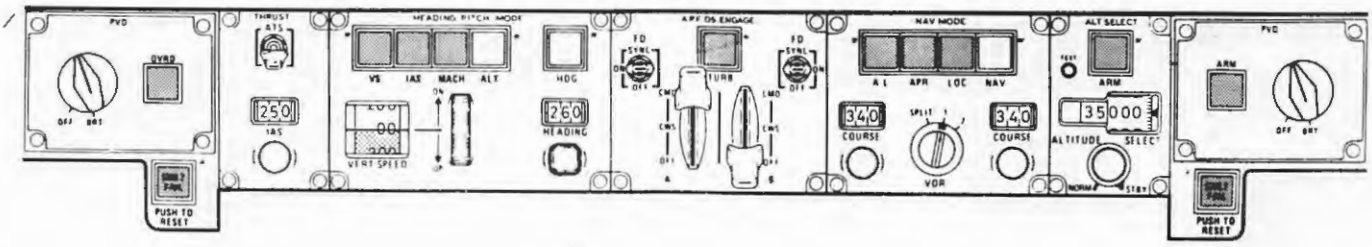
* SET No. 2 COURSE SELECTOR TO 340.

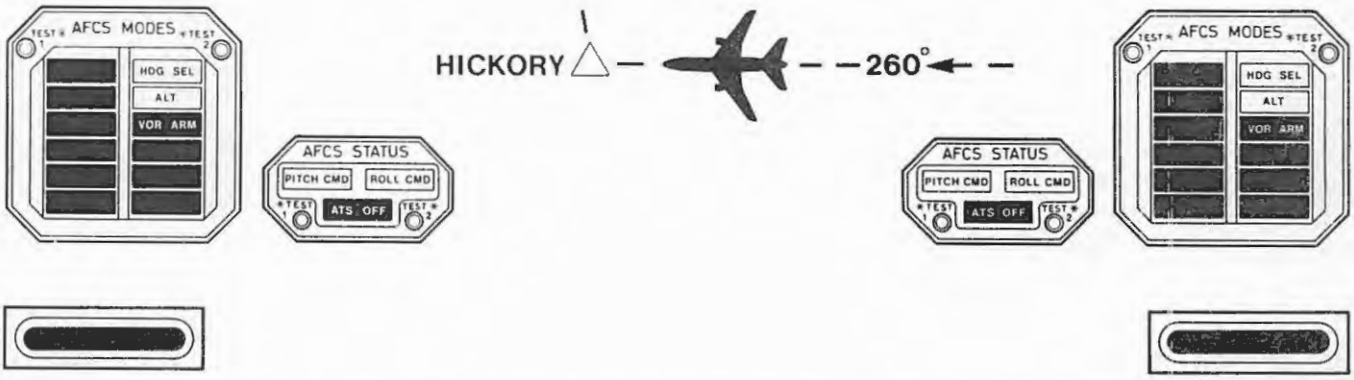
* SET ALTITUDE SELECT TO EXPECTED CLEARED FL.

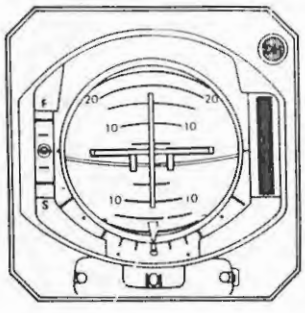
● HSI 2 displays STW VOR.

● RMI green pointers indicate QDM to STW.









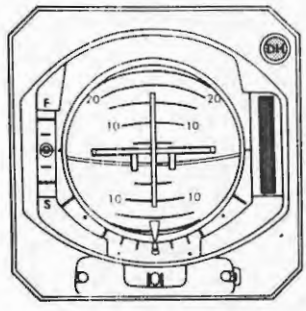
- Approaching Hickory intersection as indicated by NAV 2 display on right HSI.

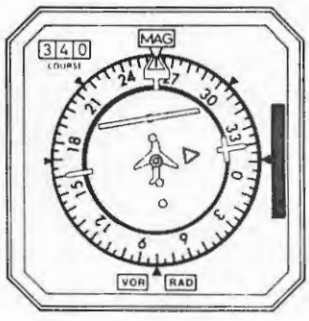
* HDG SELECT - PRESS.

* SELECT STONEWALL VOR FREQ ON NAV 1.

* NAV 1 COURSE SELECT - 340° STW OMNI-BEARING.

- HDG switchlight - lit.
  NAV switchlight - dark.





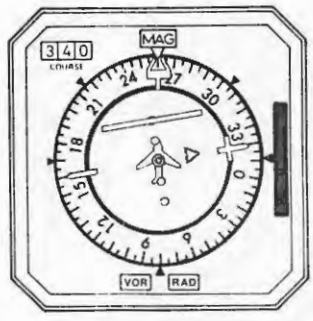
- VOR disappears and HDG SEL appears in MODE annunciators.

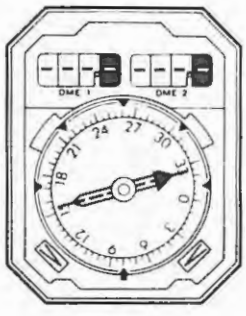
- VOR switch springs to SPLIT when NAV mode light goes out.

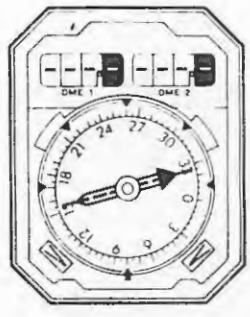
* SELECT NAV MODE AND VOR 1.

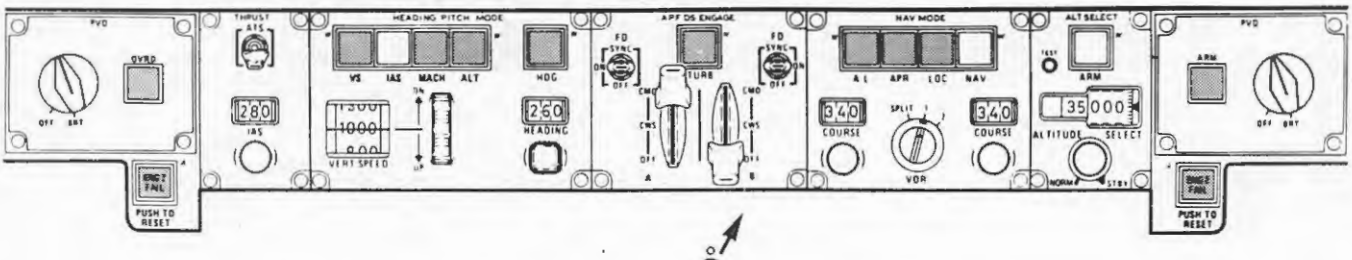
- NAV mode switchlight - lit and VOR ARM appears in mode annunciators.

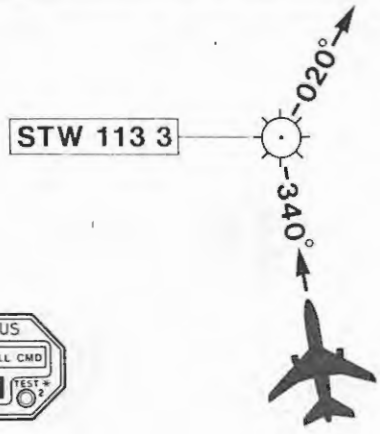
- Aircraft will start to turn on to VOR at the VOR capture point.

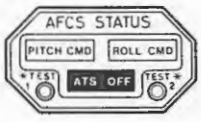


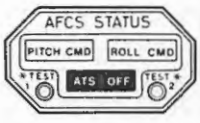


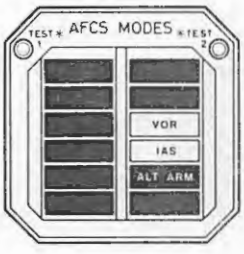


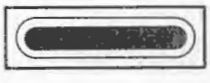


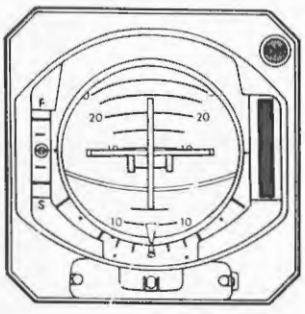












- As aircraft enters VOR capture area HDG SEL switch light - dark.
- Aircraft turns to intercept STW omni bearing.
- Mode annunciators display VOR - VOR ARM disappears.

* SET CLIMB POWER - PRESS VS PITCH MODE - ADJUST VS RATE TO ACHIEVE CLIMB SPEED.

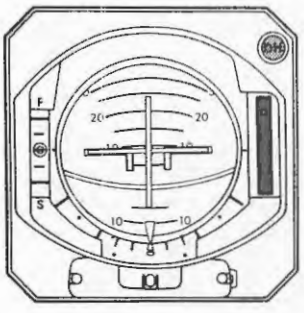
- Mode annunciators display VS - ALT disappears.

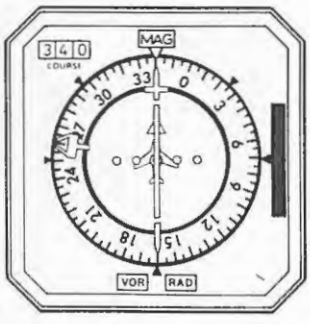
* WHEN CLIMB SPEED ESTABLISHED PRESS IAS PITCH MODE.

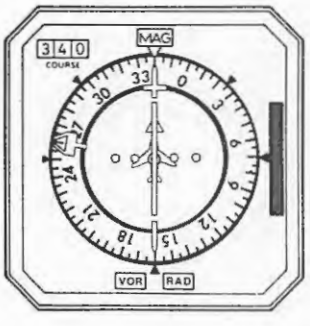
- Modes indicate IAS - VS disappears.

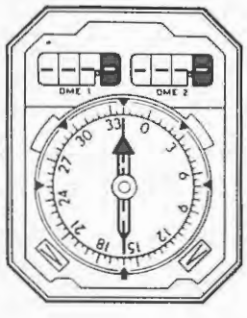
* PRESS ALT SELECT SWITCHLIGHT

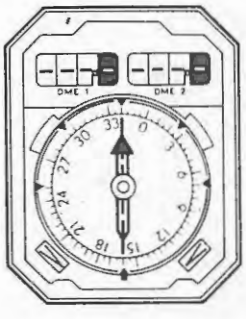
- ALT ARM - lit
- Modes display ALT ARM.

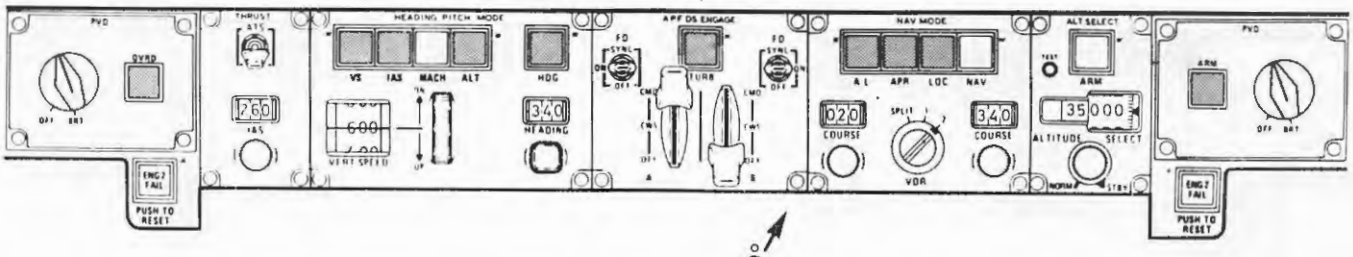




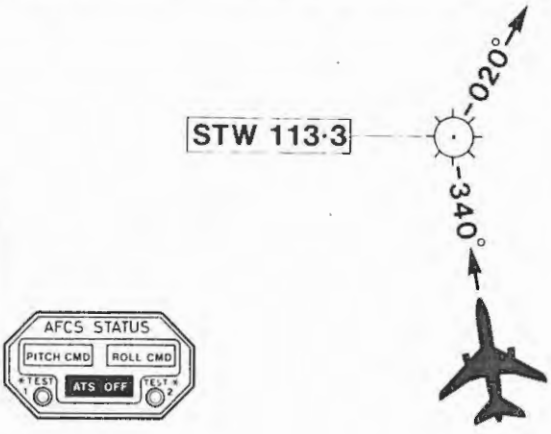


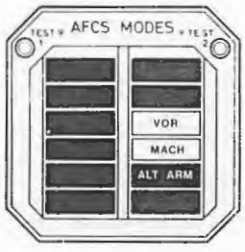


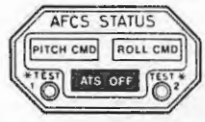


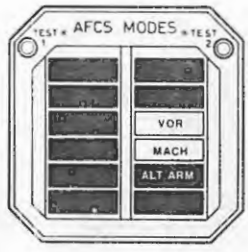


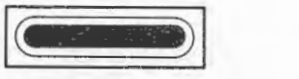
STW 113·3



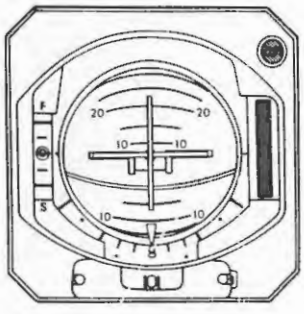




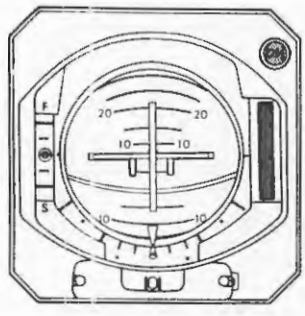




* SELECT 340° ON HDG SEL COUNTER.



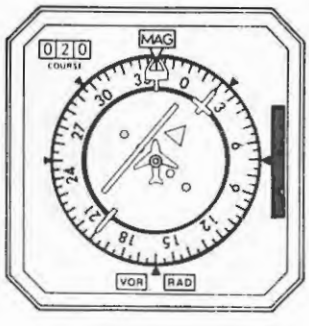
* ON HAND-OVER TO P2 SELECT VOR SWITCH TO 2.



* WITH INCREASING ALTITUDE AND VS DECREASING - MAINTAIN MACH NR - SELECT MACH MODE.

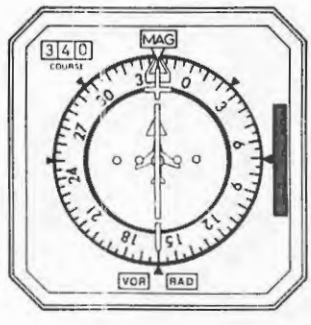
● Modes display MACH and IAS disappears.

* TUNE NAV 1 TO MAGNOLIA VOR - SELECT 020 ON NAV 1 COURSE SELECTOR.

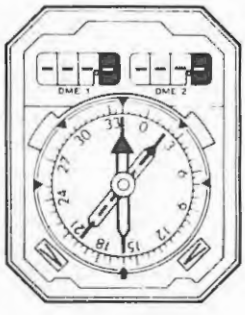


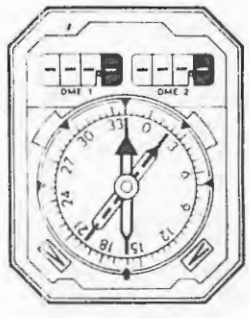
● Monitor tracking of Stonewall radial on right HSI and closure with selected Magnolia omni bearing on left HSI.

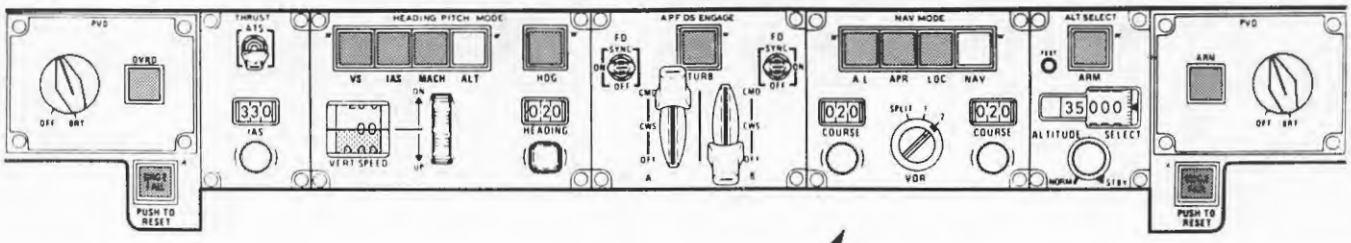
* SET IAS COUNTER TO ACHIEVED IAS.



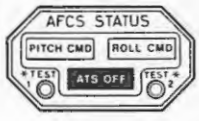
● Speed ringsights to centre.

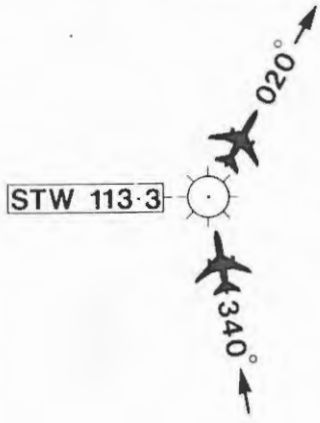




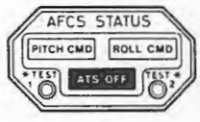


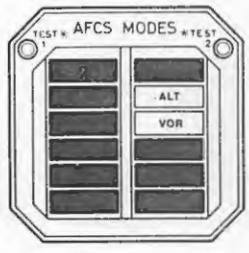
ALTITUDE
ON AT 34250
OFF AT 34750

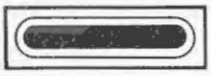


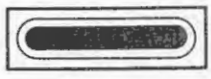


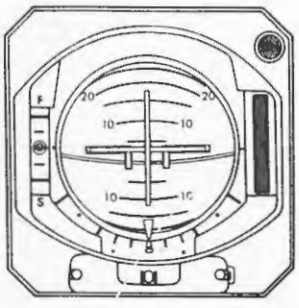
ALTITUDE
ON AT 34250
OFF AT 34750





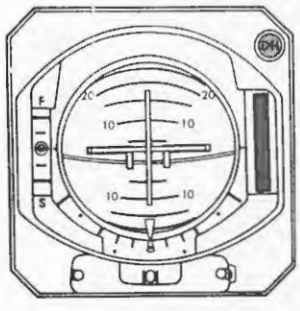


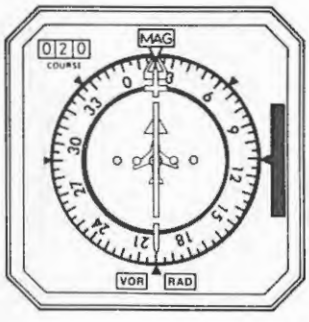




- As aircraft goes through 34250 ALTITUDE alert lamps - lit, at 34750 lamps - dark.
- There is an aural warning of approaching selected height.
- MACH mode disappears - aircraft flares on to FL 350 - ALT ARM is replaced by ALT mode.
- MACH and ALT ARM switchlights - dark. ALT switchlight - lit.

* WHEN DME INDICATES STONEWALL SELECT NAV 2 COURSE SELECTOR TO 020.

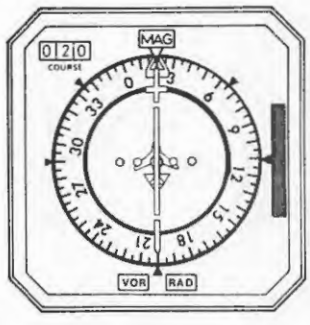


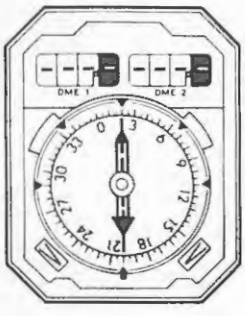


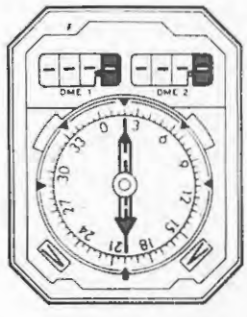
- Aircraft turns on to 020 - right HSI shows 'from' indication - aircraft establishes on outbound radial.

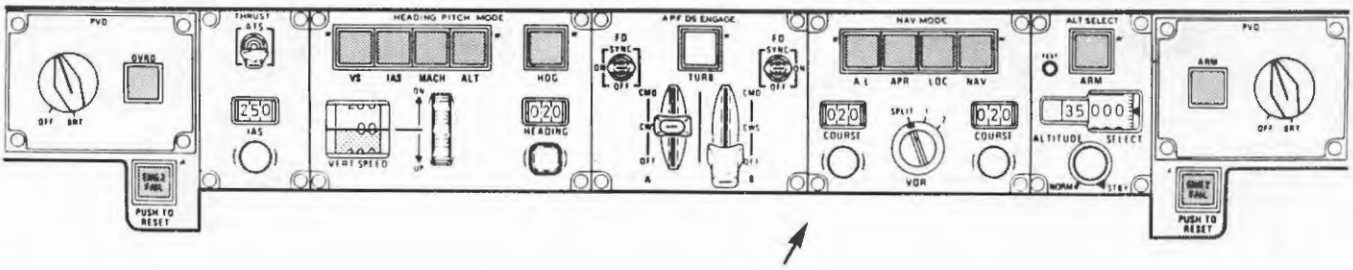
* SET HEADING COUNTER TO 020.

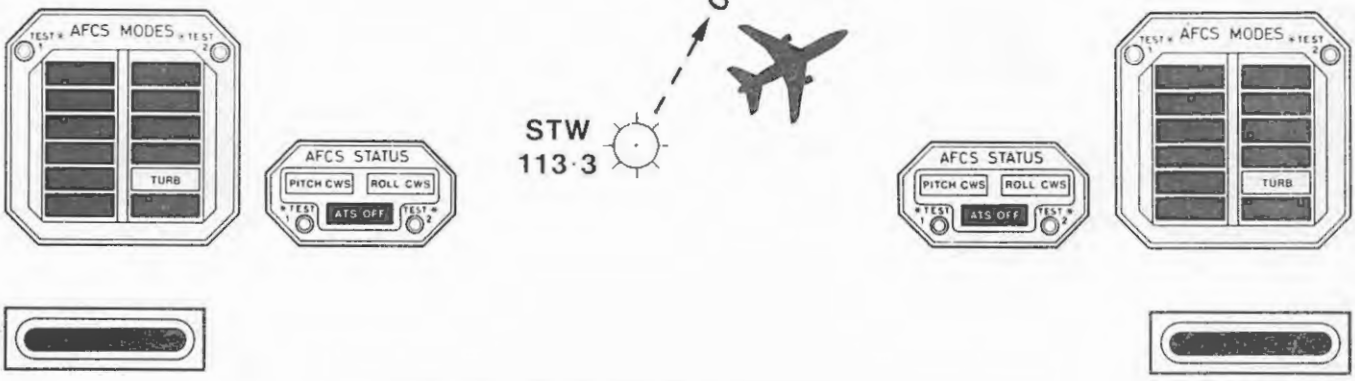
* RESET IAS COUNTER TO CRUISE SPEED - CHECK SPEED POINTERS.

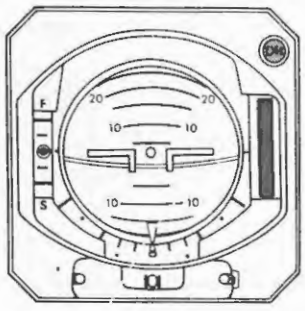


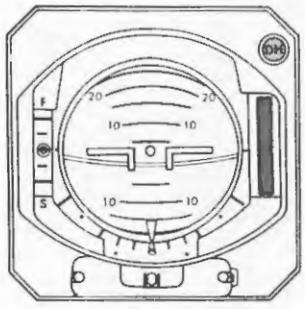












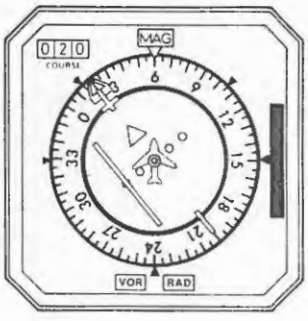
- Aircraft enters area of turbulence.

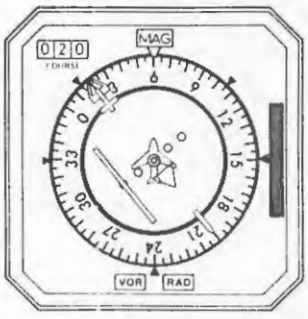
* TURB MODE SWITCH PRESSED.

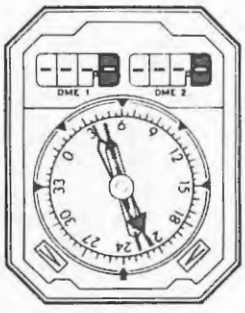
- Flight directors park. Engaged AP drops to CWS.
- All previously engage modes disengage - Mode annunciators clear and are replaced by TURB.
- TURB switchlight is lit - all others dark.
- AP A operates in CWS mode but responses are reduced to half rate.

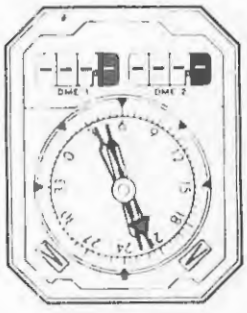
* IAS COUNTER TO RECOMMENDED TURBULENCE PENETRATION SPEED

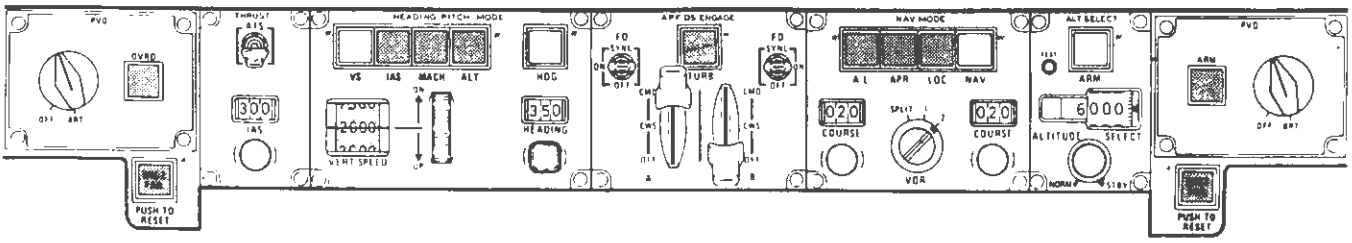
* ALTER COURSE AS NECESSARY THROUGH AP IN CWS

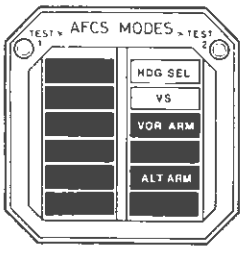




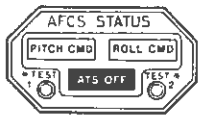


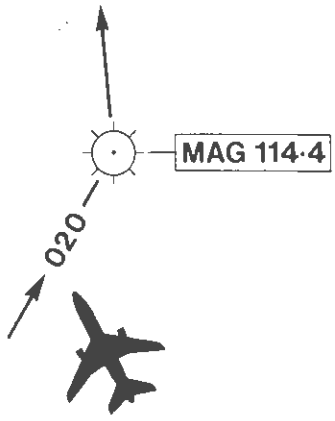


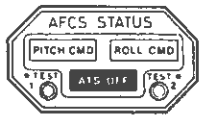




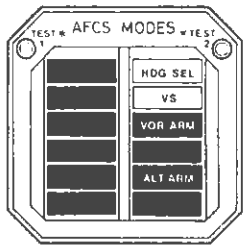
ALTITUDE
ON AT 6750
OFF AT 6250

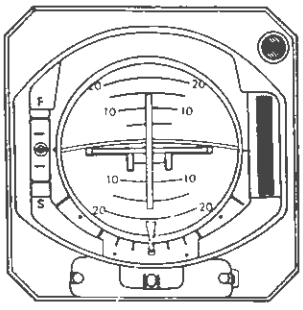






ALTITUDE
ON AT 6750
OFF AT 6250



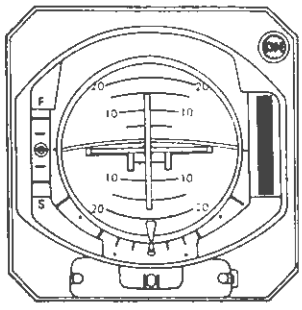


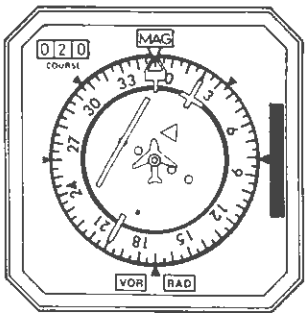
* WHEN CLEAR OF TURBULENCE PRESS TURB SWITCHLIGHT TO DISENGAGE MODE.
SET SELECT HDG FOR VOR INTERCEPT.

● TURB switchlight - dark.
HDG switchlight - lit. Director indices in view.

* SELECT MAGNOLIA FREQ ON NAV 2.
ENGAGE AP A to CMD.
ENGAGE NAV MODE. SET VOR SWITCH TO 2.
ENGAGE ALT.

● AFCS STATUS indicates CMD in pitch and roll.
Mode annunciators show HDG SEL, VOR ARM.

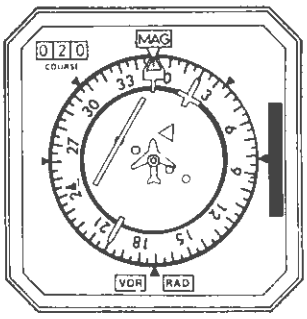


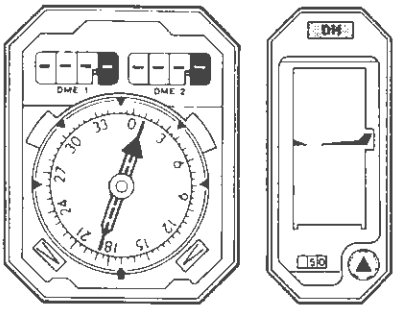


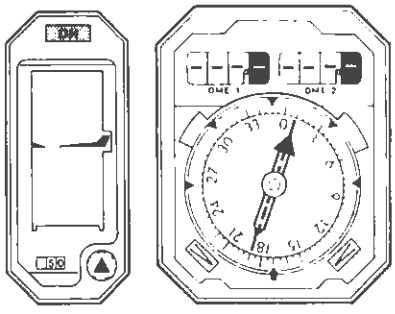
CLEARANCE - DESCEND TO 6000 FT. LEAVE MAGNOLIA ON A HEADING OF 345. AFTER LEAVING MAGNOLIA DESCEND TO 2500 FEET. ON INTERCEPTING DXN LOC CONTINUE ILS APPROACH.

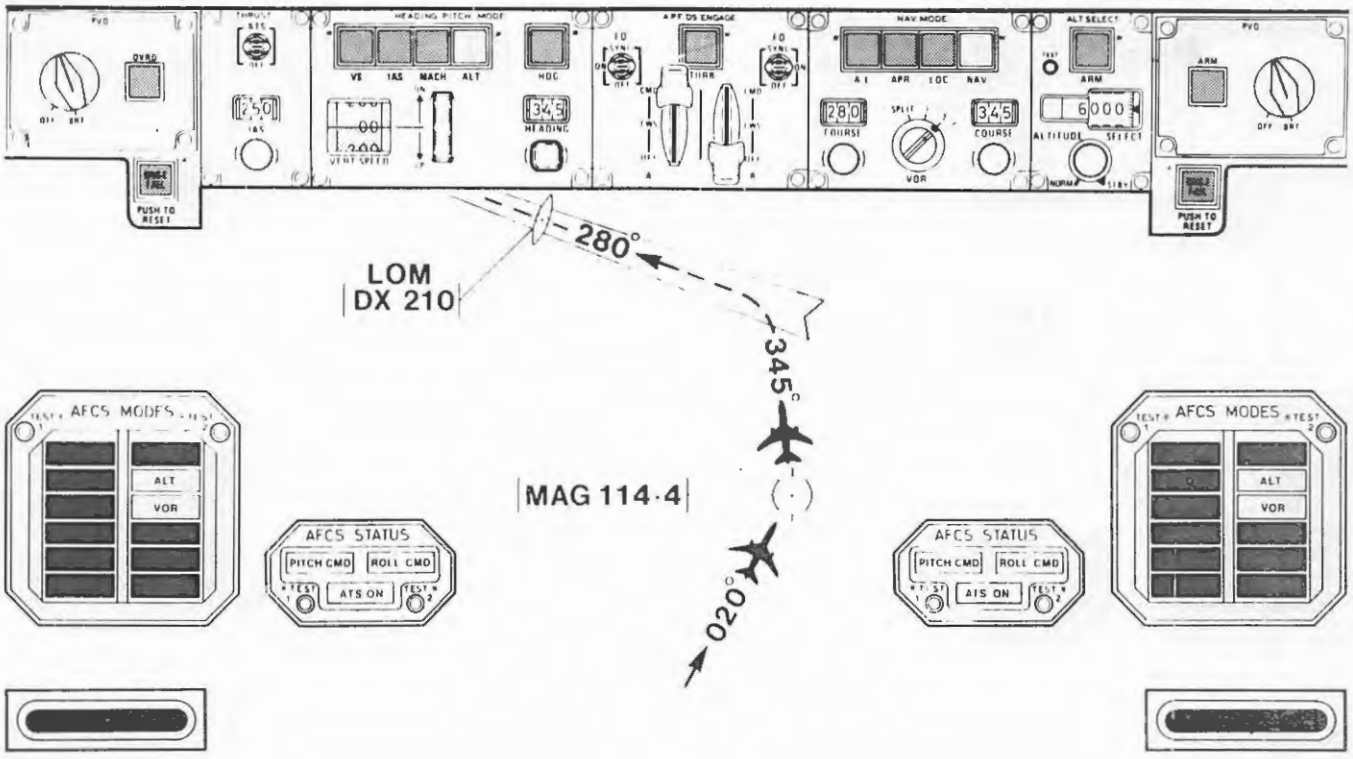
* PRESS VS. SET REQUIRED RATE. ADJUST POWER.
SET CLRD ALT IN ALT SELECT WINDOW. SET QNH.
PRESS ALT ARM. SET RADIO DECISION HT.

● Mode annunciators show VS ALT ARM.

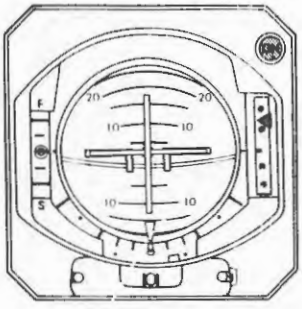


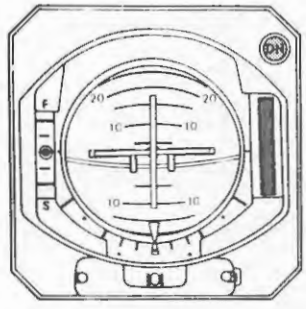






* AT LOWER LEVEL SET IAS COUNTER TO CURRENT AIRSPEED. SELECT ATS ON. ADJUST IAS TO REQUIRED SPEED.

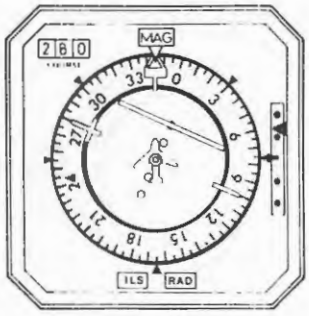


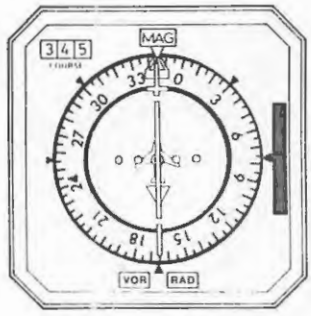


- AFCS STATUS shows ATS ON.
  Aircraft maintains selected IAS.

- At 6750 ft. ALTITUDE lamps - lit.

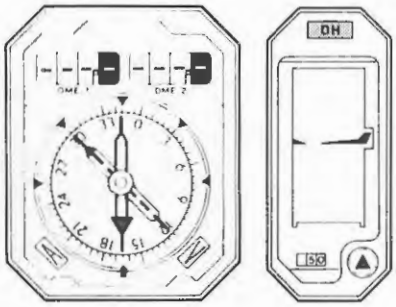
- At 6250 ft. ALTITUDE lights - dark.
  Aural warning sounds.
  Aircraft flares to 6000 ft.
  VS switchlight - dark
  VS mode clears.
  At 6000 ft. ALT ARM is replaced by ALT.
  ALT switchlight - lit.

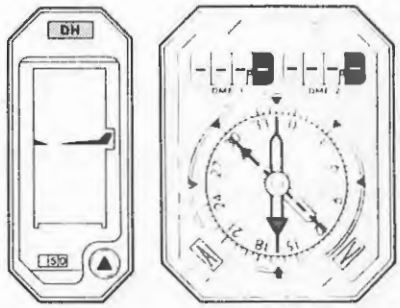


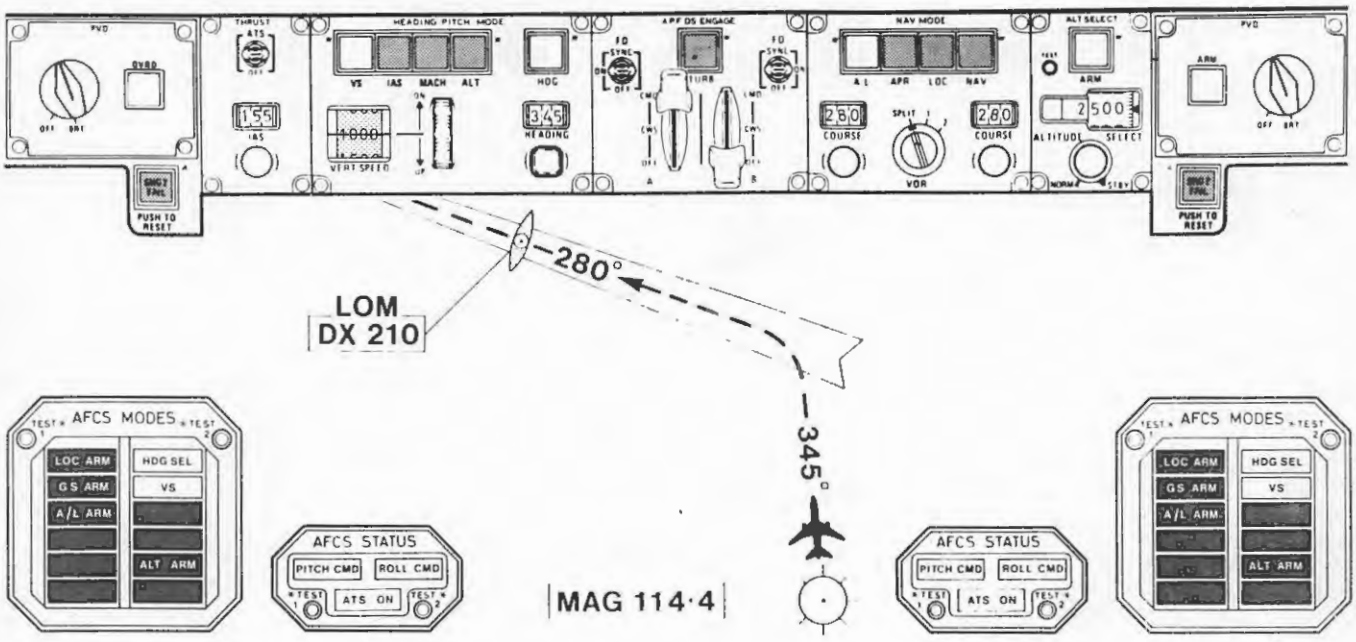


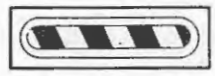
* SELECT NAV 1 TO DXN ILS FREQ.
TUNE ADF 1 TO DIX LOCATOR.
OVER MAG SELECT NAV 2 COURSE SELECTOR TO 345.
NAV 1 COURSE SELECTOR TO 280°.

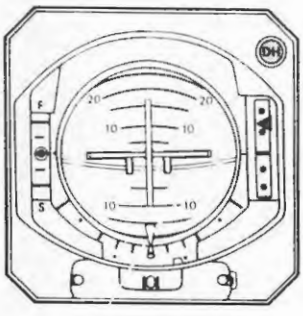
- Aircraft turns on to new track for localiser intercept. Left HSI and ADI display ILS.











* LEAVING MAG. SET QFE. ALT SEL TO 2500.
PRESS ALT ARM. PRESS VS. ADJUST VS RATE.

● Mode indications VS, VOR, ALT ARM.

* SET REQUIRED IAS - CHECK AUTO THROTTLE RESPONSE AND SPEED RINGSIGHTS. FLAPS AS REQUIRED.

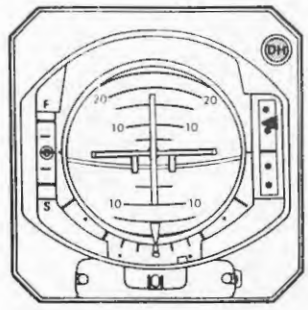
* PRESS HDG SEL.

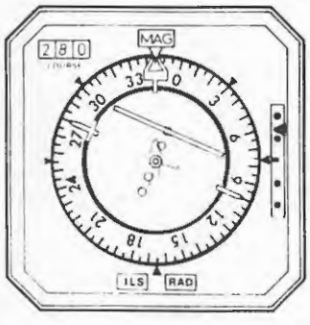
● VOR switch moves to SPLIT.

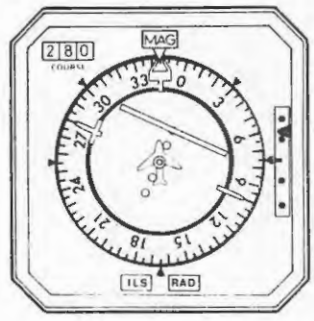
* TUNE NAV 2 TO DXN FREQ 109.9. COURSE SELECTOR TO 260. TUNE ADF 2 TO OVERSHOOT BCN.

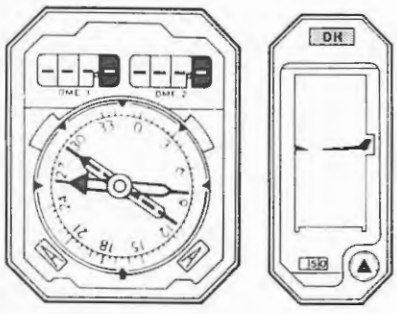
● Mode switchlights ALT ARM, VS, A/L.
Additional mode annunciators LOC ARM, GS ARM, A/L ARM.

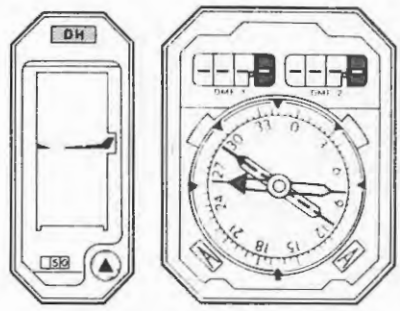
* PRESS PVD ARM & OVRD - ADJUST PVD LIGHTING.
RELEASE OVRD. PVD SHUTTERS.

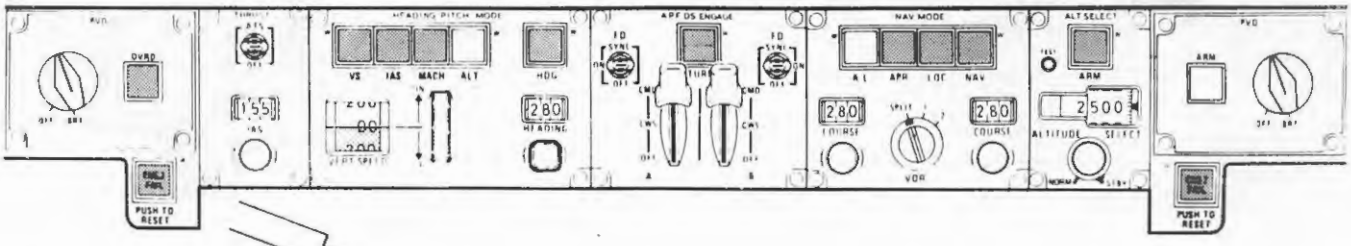


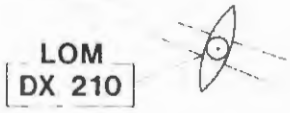


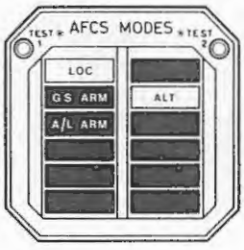


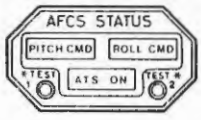


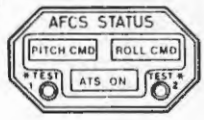


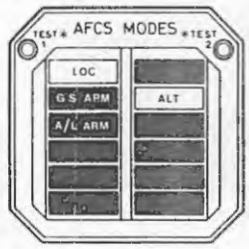




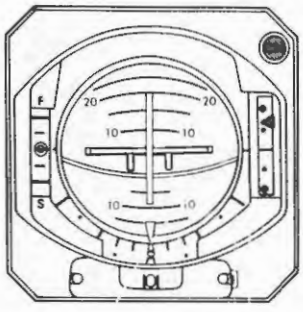






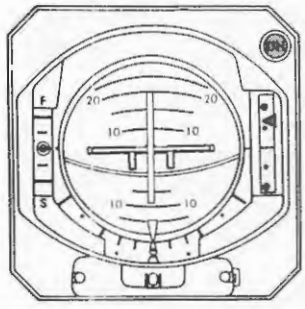


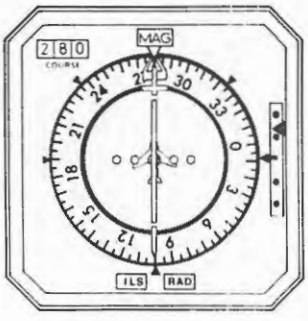
* SELECT AP B TO CMD

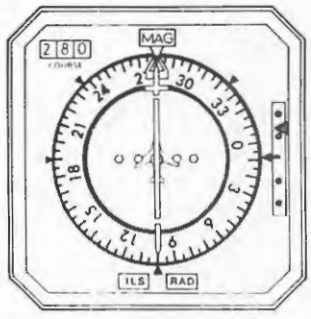


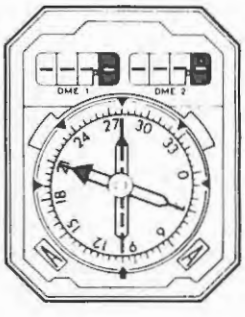
UPON LOCALISER CAPTURE

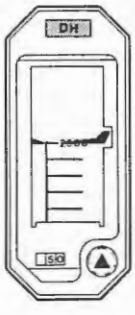
- LOC replaces LOC ARM and HDG SEL.
- At 3250 feet ALTITUDE - lit.
- At 2750 feet ALTITUDE - dark. aural warning sounds.
- Radio altimeter scale now in view.
- VS mode is replaced by ALT. Altitude maintained until glideslope capture.

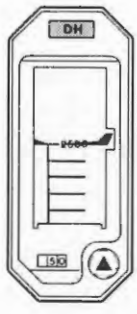


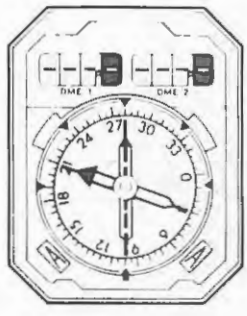


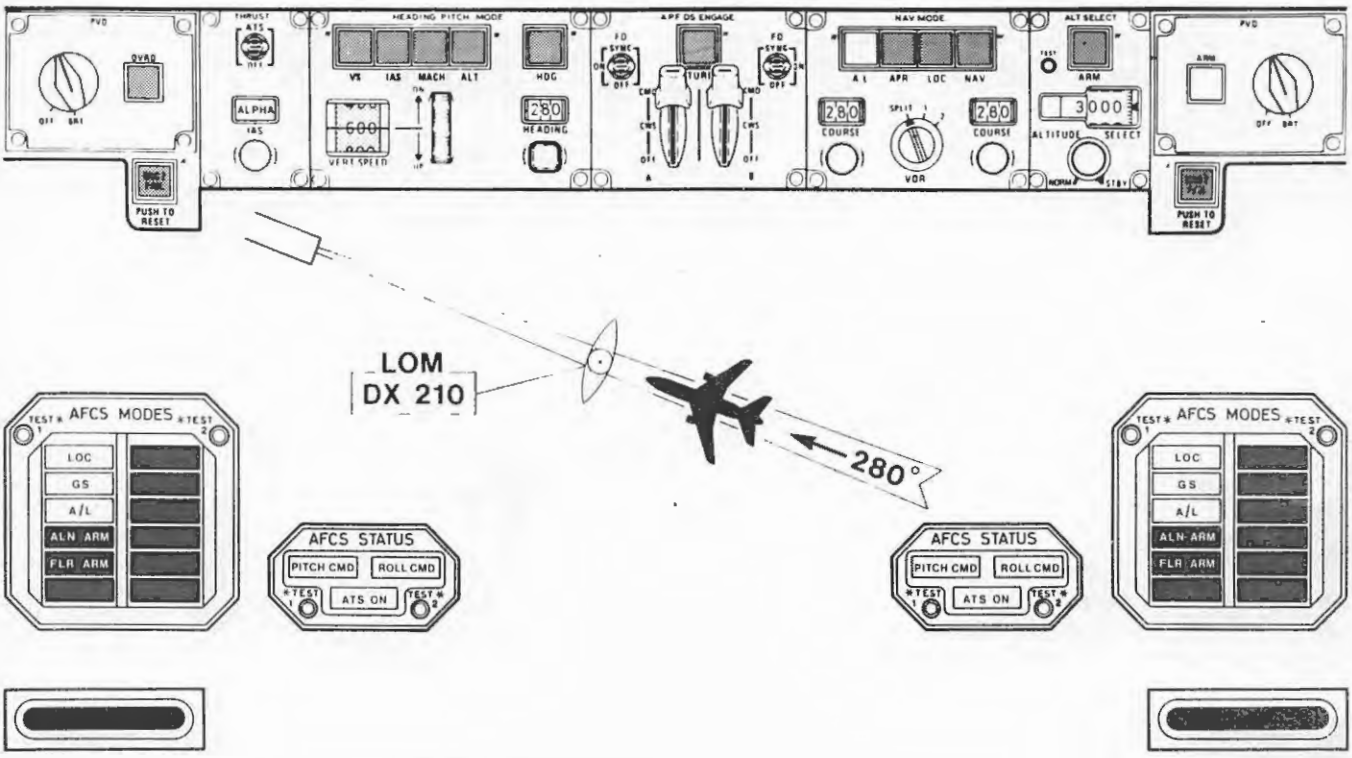




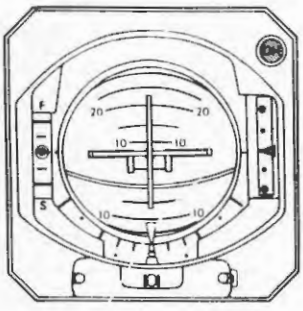


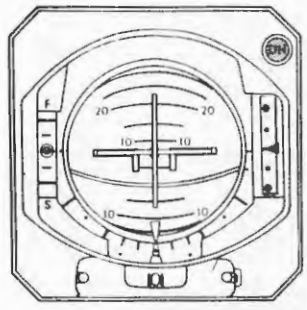






UPON GLIDESLOPE CAPTURE



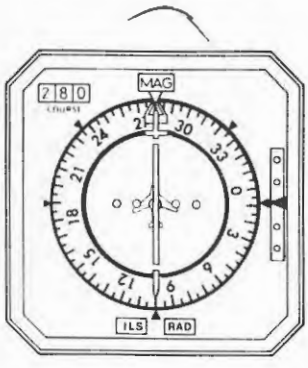


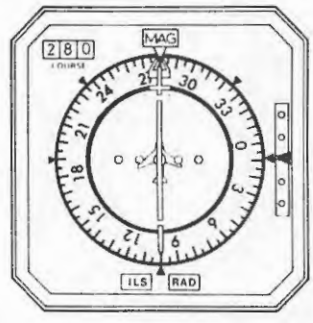
- ALT mode is replaced by GS.
  Aircraft pitches down and tracks GS.

* LEAVING 2500 FEET ALTITUDE LAMPS WILL FLASH.
RESET ALT SEL TO OVERSHOOT HEIGHT OR ABOVE
3000 FT. TO STOP FLASHING.

AT 1500 RADIO HEIGHT

* SELECT FLAP 42.





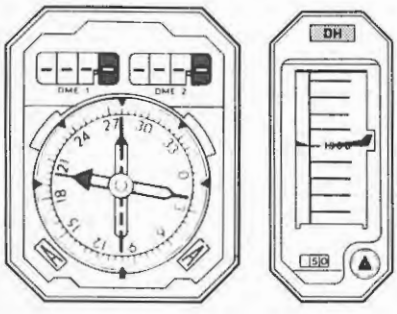
- A/L replaces A/L ARM.
  ALN ARM and FLR ARM appear.

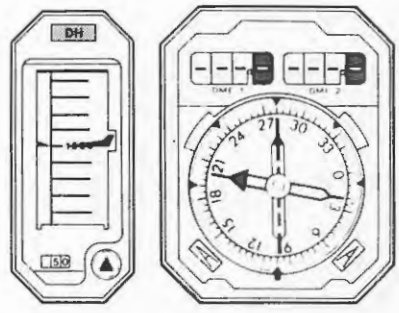
- Rudder goes into parallel YAW SAS
  operation with full authority.

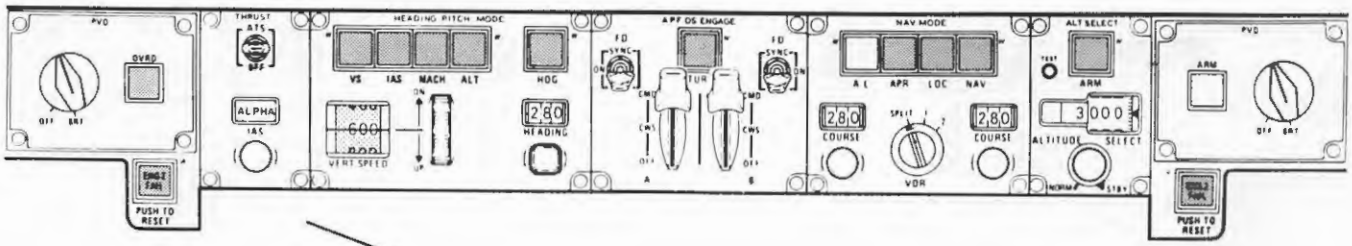
- Pitch trim is biased nose up.

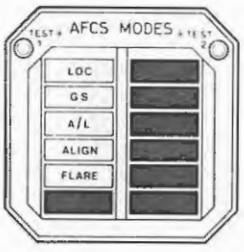
- Direct lift control operates.

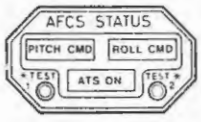
- Auto throttle operates in ALPHA mode (1.3 Vs)

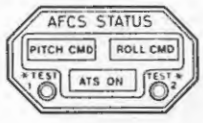


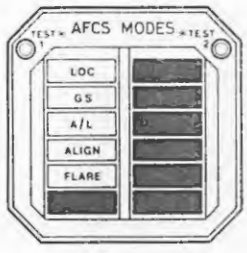


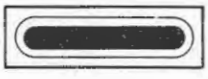


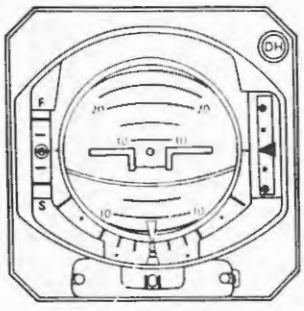










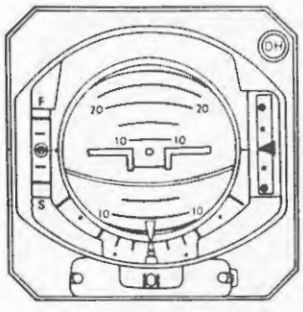


BELOW 1500 FEET

* SELECT FLIGHT DIRECTORS OFF.

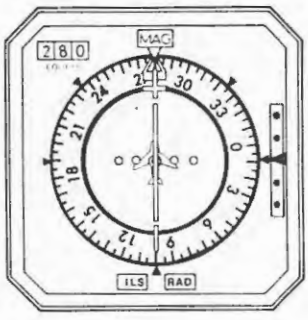
* CHECK OVERSHOOT HEIGHT SET ON ALT SELECT.

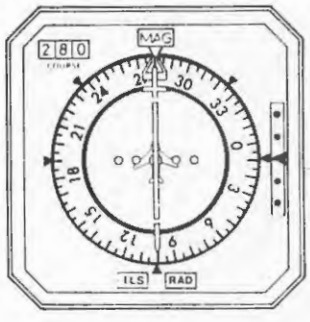
- ILS DEVIATION lights are armed to give warning of excessive deviation from LOC or GS.
- Speed control datum ALPHA. Automatically increased by gust compensation if necessary.



AT 150 FEET

- ALIGN is annunciated.
- Aircraft aligns with runway and sets up any crosswind correction.
- At 50 feet above DH a pulsing aural tone is heard in telephones.
- Aural tone pulsing rate increases as DH is approached.

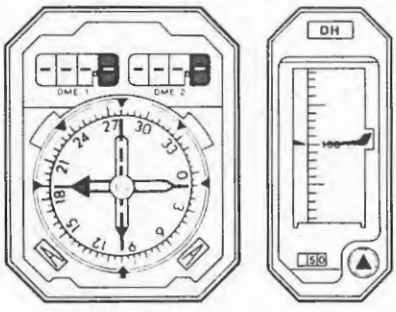


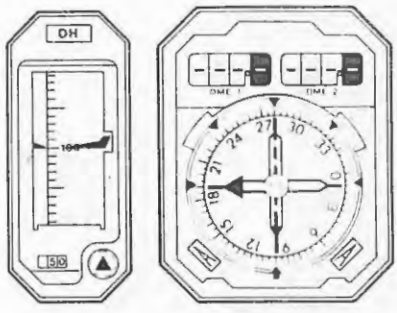


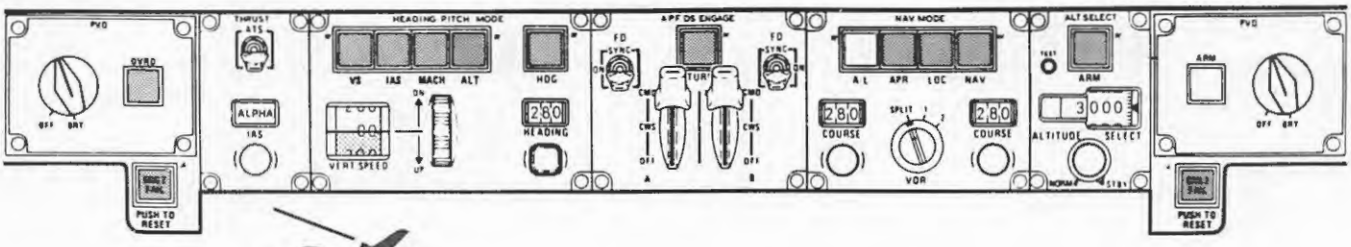
AT DH

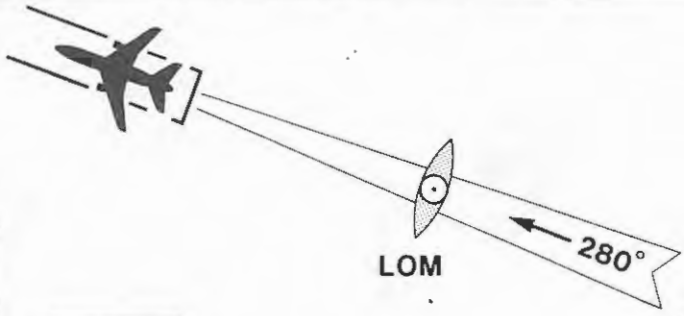
- Aural tone stops. DH lamps on RA and ADI - lit.

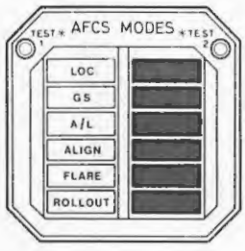
* PRESS RA DH LAMP TO EXTINGUISH RA AND ADI LAMPS.

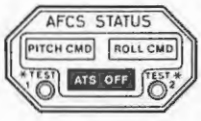


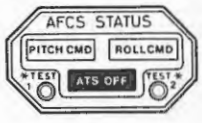


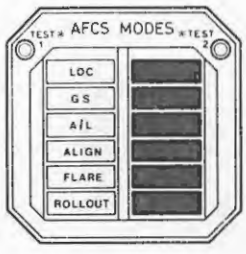


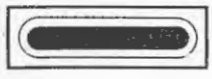


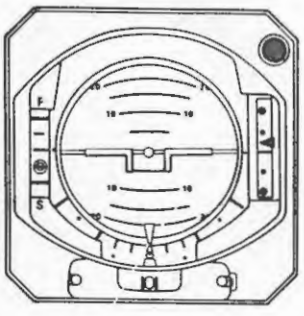












AT 50 FEET RADIO HEIGHT

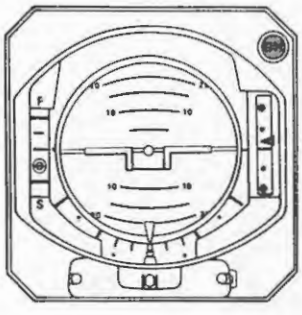
- FLARE is annunciated and flare is automatically initiated.
- Auto throttle starts to retard throttles.

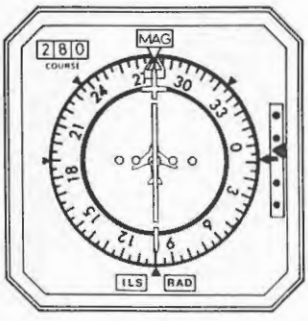
AT 5 FEET RADIO HEIGHT

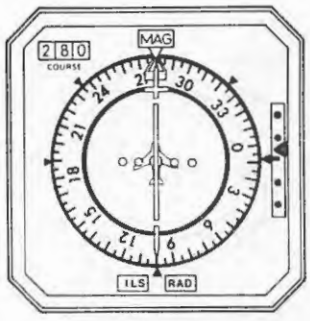
- ROLL OUT is annunciated, crosswind correction is removed, control on centre line effected through YAW SAS by localiser and yaw rate signals.
- Automatic landing is accomplished.

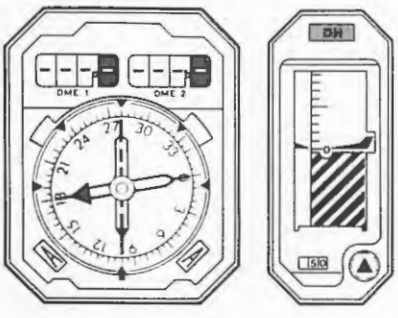
AT TOUCHDOWN

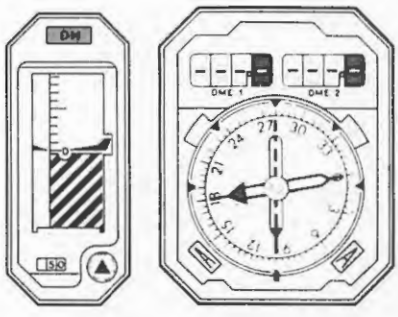
- Automatic Ground Spoilers deploy.
- Throttles drive to close and ATS disconnects.
- ROLL OUT control through Yaw SAS and limited automatic nose-wheel steering until autopilot is disconnected.
- Ground Run Monitor indicates runway length remaining through ROLL OUT.
- Para Visual Directors will unshutter on touchdown and give roll out guidance if auto roll out not available.











RADIO

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INTRODUCTION The systems provided are as follows:-

COMMUNICATIONS

1 HF System (SSB)
2 VHF Transceivers
1 Flight Interphone
1 Audio Integrating System
1 Cabin Interphone System
1 Galley Interphone System
1 Service Interphone System
1 Cockpit Voice Recorder
1 Passenger Address System
1 Passenger Audio Entertainment System

NAVIGATION

2 VOR Systems
2 DME
2 ILS Localisers
2 Glide Paths
2 Markers
2 ADF
2 Radio Altimeters
2 ATC Transponders
2 Weather Radars
1 Flight Recorder
1 Underwater Sound Locating Device

LOCATION OF UNITS There are three stowage areas underfloor. They are:-

Forward Electronics Service Centre which contains the majority of the equipment in a rack. The units housed are:-

Communications	Navigation
HF	VOR RECEIVERS
VHF	ILS RECEIVERS
FLIGHT INTERPHONE AMP.	MARKERS
SERVICE INTERPHONE AMP.	DME
AUDIO DISTRIBUTION UNIT	ATC TRANSPONDERS
P.A. AMPLIFIERS	WEATHER RADARS

Mid Electronics Service Centre

TAPE REPRODUCER

ADFs
RADIO ALTIMETERS

Aft Electronics Equipment Area

FLIGHT DATA RECORDER
UNDER WATER SOUND LOCATING DEVICE
COCKPIT VOICE RECORDER

CONTROLLERS

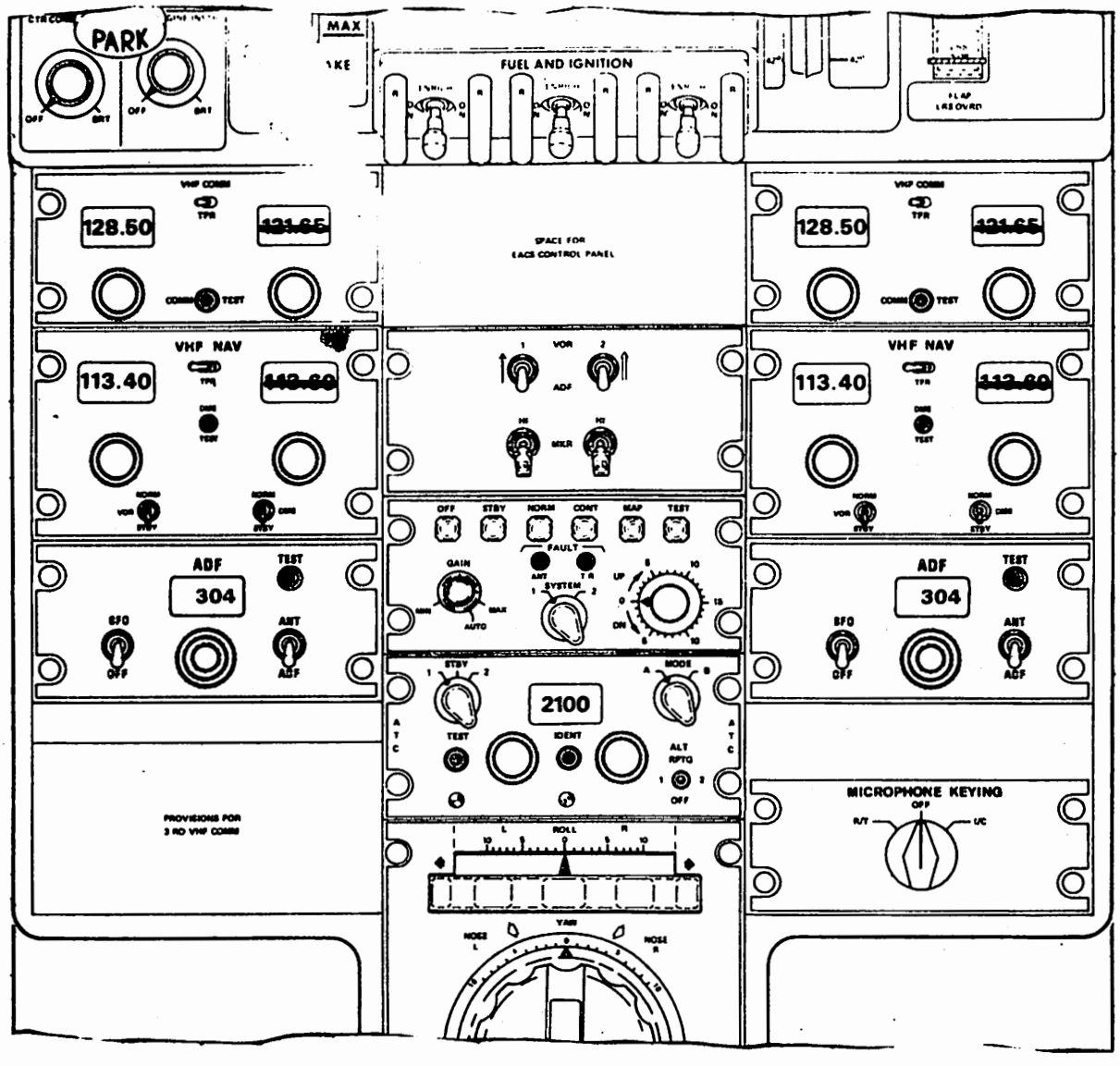
On the roof panel are controllers for:-

DUAL HF
COCKPIT VOICE RECORDER
CABIN INTERPHONE
PASSENGER ADDRESS

On the systems station lower right is the :-

FLIGHT DATA RECORDER controller

Other controllers are on the centre pedestal.

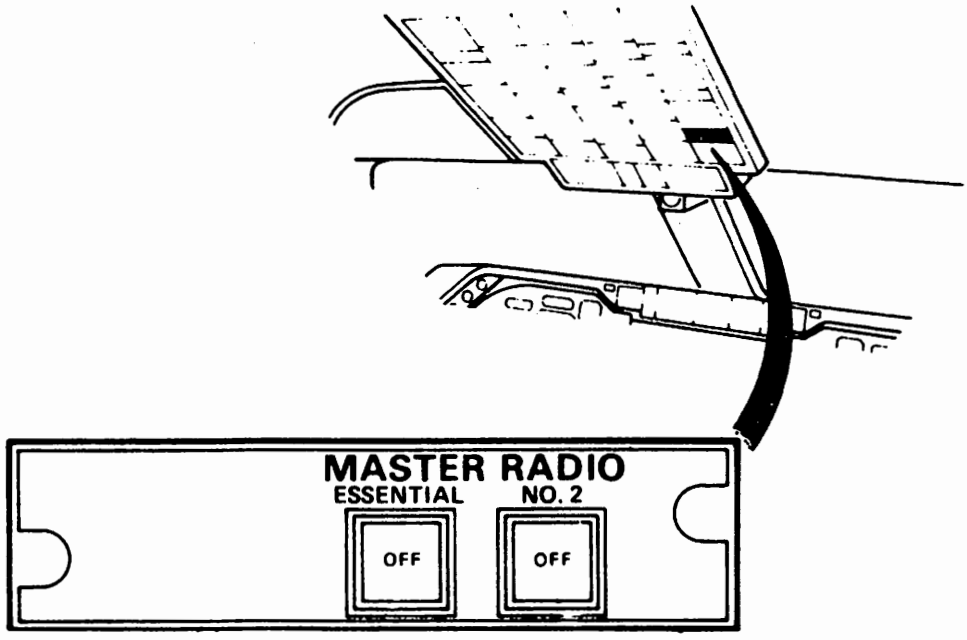


CENTRE PEDESTAL

RADIO POWER SUPPLIES

INTRODUCTION

Two Master Radio switchlights on the right hand side of the overhead panel are labelled ESSENTIAL and No. 2. They do NOT control all radio supplies. Some equipments derive their supplies directly from aircraft busbars and are unaffected by the MASTER RADIO switches.



MASTER RADIO ESSENTIAL SW

This controls power supplies from the following busbars:-

ESSENTIAL DC
BATTERY
ESSENTIAL AC

These supplies are used by the following equipments:-

VHF1
AUDIO SELECTORS
FLIGHT INTERPHONE
P.A.
MARKER 1
HF 1
WEATHER RADAR 1
DME 1
COCKPIT VOICE RECORDER

MASTER RADIO No. 2 SW

This controls power supplies from the following busbars:-

DC BUS 2
AC BUS 2 EXTENSION

and supplies:-

MARKER 2
ADF 2
WEATHER RADAR 2
DME 2
ATC TX 2

EQUIPMENT SUPPLIED DIRECT FROM BUSBARS

The DC GROUND SERVICE BUSBAR supplies:-

ALL INTERPHONE SYSTEMS
AUDIO SELECTOR PANELS
MECHANIC CALL
VHF 2

The ESSENTIAL AC BUS supplies:-

RADIO ALT 1
INST TRANSFORMER 2

The AC BUS 2 supplies:-

RADIO ALT 2
ILS 2
INST TRANSFORMER 3

The DC BUS 2 supplies:-

VOR 2.

The AC STANDBY BUS supplies:-

ILS 1
ATC TX 1
INST TRANSFORMER 1

The DC STANDBY BUS supplies:-

VOR 1
ADF 1

COOLING AIR SUPPLIES

Cooling air is drawn through the equipment racks in the FESC and MESC by exhaust fans. It is then discharged by ducting and control valves to either the underfloor areas (normal flight condition) or overboard (on ground condition). If an exhaust fan fails in flight, the cooling air supply is maintained by pressurisation leak to atmosphere.

AUDIO INTEGRATING SYSTEM

INTRODUCTION

The audio integrating system provides for the selection of transmitting and receiving facilities and intercommunication between crew members.

It also interfaces with the cabin, galley and service interphone systems and with the PA.

HEADSET MICROPHONE SOCKETS

A jack panel and headset/boom microphone stowage is provided for all five crew member positions. The jack panel contains two sockets:-

(a) one for the headset plug
(b) one for the boom microphone plug

The oxygen mask microphone is permanently wired into the system and an adjacent switch provides for the selection of boom or oxygen mask microphone.

The locations are:-

P1 and P2 - forward end of side console
P3 - lower left of systems station
P4 - at the rear of the port side console
P5 - above his head on the oxygen mask stowage module.

AUDIO SELECTOR PANELS

Five audio selector panels are located:-

P1 - forward end of port side console
P2 - forward end of starboard side console
P3 - lower left of systems station at table level
P4, P5 - shared - rear of port side console
FESC- near the access door from flight deck.

CONTROLS

See illustration

PTT SWITCHES R/T - OFF - I/C

These are located:-

P1 and P2 - on the outboard horn of each control column
P3 - right rear of centre pedestal
P4 - rear of port side console
P5 - above his head on oxygen stowage module

on each audio selector panel.

FLIGHT DECK LOUDSPEAKERS

In the rear roof of the flight deck are two loudspeakers. One for chime calls and the other to monitor the PA system.

In addition P1 and P2 each have a speaker facing inboard at the forward end of each side console. These may be used independently to monitor the audio selections made on their individual audio selector panels. They are muted whenever a transmit switch is pressed. An ON/OFF switch with a combined volume control is mounted on each speaker

POWER SUPPLIES

The system may be powered from three sources:-

(i) Battery busbar
(ii) DC Essential busbar
(iii) Ground service busbar

In the normal case the Essential Radio Master Switch is pressed to ON and the system is available.

If the DC Essential busbar fails the battery bus takes over automatically.

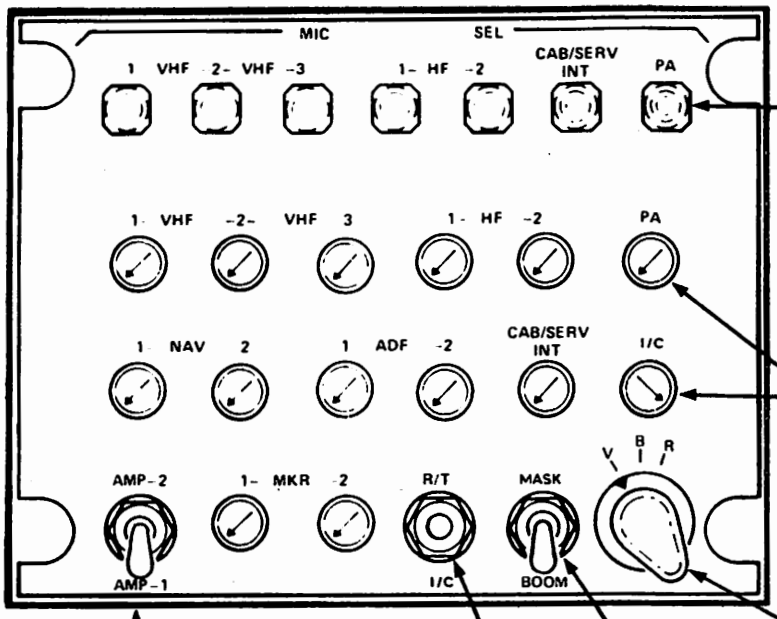
If only the battery supply is available (towing) then, if the battery switch ONLY is placed to ON, the system is available.

On the pilots overhead circuit breaker panel 1 are three C/Bs:-

1A 12 Audio control P1, P3
1A 13 Audio control P2, P4
1A 14 Flight Interphone

The system also has a parallel supply source from the Ground Service Busbar through C/Bs 3C 16, 3C 17, 3C 18.

AUDIO SELECTOR PANEL



MICROPHONE SELECTORS

Press to select Mic to Transmitter, interphone or P.A.
Interlocked so only one remains depressed at a time.
Lights up when depressed.

AUDIO SELECTORS

Press in to select.
Rotate for volume control.

DME Audio selected by NAV button.

PA has a fixed sidetone volume.

VOICE/BOTH/RANGE FILTER

Operates only on NAV and ADF selections. With a NAV selection and voice position DME ident is suppressed.

AMPLIFIER SELECTOR SWITCH
Either amplifier provides full facilities.

Selects Oxygen or Boom Microphone for I/C or R/T.

R/T / OFF / FLT INTERPHONE SW.

May be used for keying Selected MIC to selected Transmitter or interphone instead of using control column R/T / OFF / I/C Sw.

COCKPIT VOICE RECORDER

INTRODUCTION

The function of the voice recorder is to monitor the audio selections made by P1 and P2 each on one track of a four track tape recorder with another track monitoring an open microphone in the roof panel to pick up general conversation. The tape is a closed loop which lasts for 30 minutes. The next 30 minutes is then recorded with erasure of the previous recording. A bulk erase facility is available at the end of a trip with the aircraft on the ground and the parking brake ON.

POWER SUPPLY

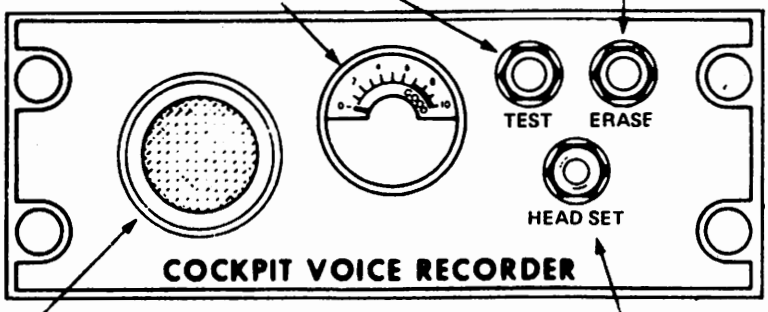
ESSENTIAL RADIO AC BUS C/B 1D 1.

TEST SWITCH AND INDICATOR

Momentary push button switch that checks the recorder unit. When switch is pressed, the needle in the indicator should indicate in the GOOD area.

ERASE SWITCH

Depressing momentary pushbutton switch for 2 seconds erases entire 30 minutes of tape, provided aircraft is on the ground and parking brake is set.

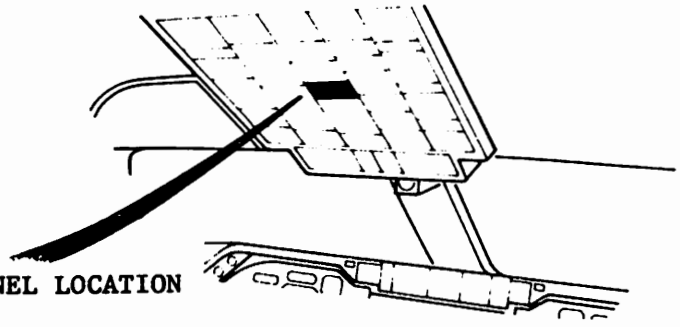


COCKPIT MICROPHONE

Activated open when essential master radio switch is on and powered.

HEADSET JACK

Permits system performance check by monitoring what has been recorded.



COCKPIT VOICE RECORDER CONTROL PANEL LOCATION

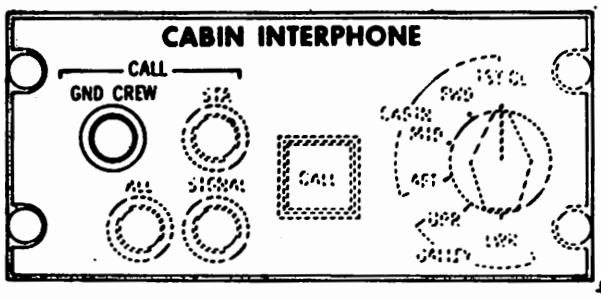
FLIGHT DECK/GROUND CREW CALL SYSTEM

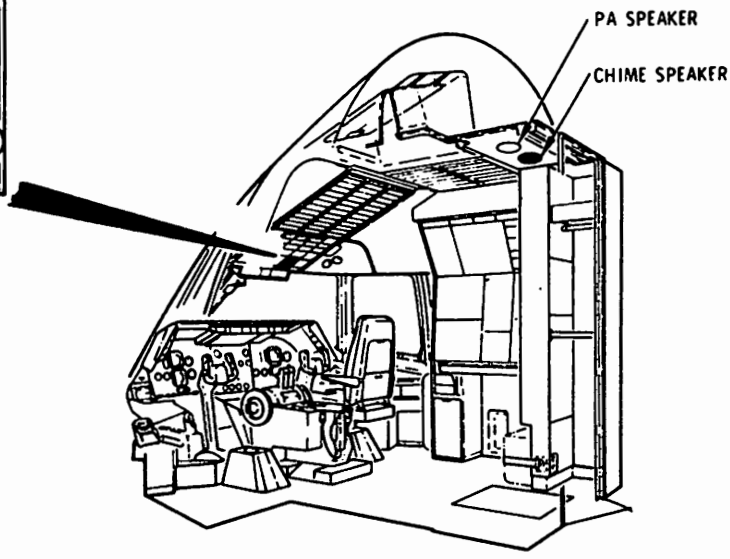
INTRODUCTION

The call system enables the flight deck crew and the ground engineer to alert one another to an interphone contact.

FLIGHT DECK CONTROLS

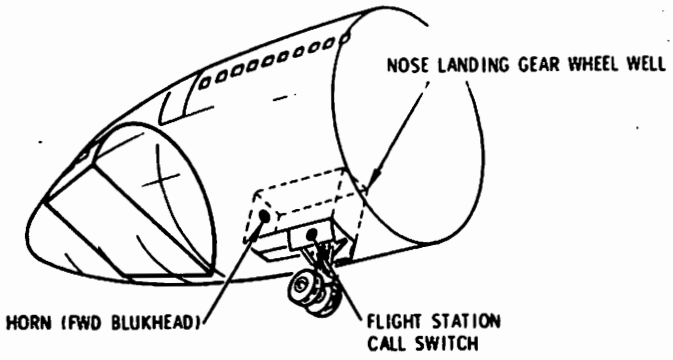
On the cabin interphone panel on the pilot's roof panel is a push button CALL - GND CREW. When this is pressed a horn sounds in the nosewheel well. The ground engineer can then plug in his boom headset at a jack position on the nose wheel door and communicate over the FLT INTERPHONE system.

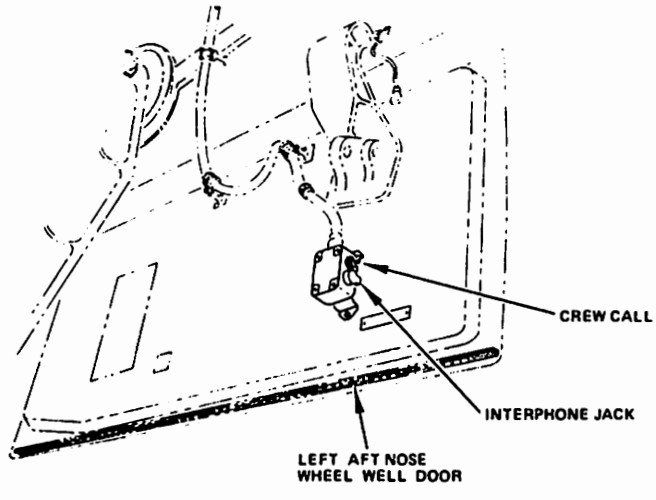




EXTERNAL CONTROLS

Mounted on the nose landing gear left aft door is an interphone call box into which the ground engineer can insert his headset/microphone plug. On the call box is a press to call button which, when operated, sounds a LOW chime in the Flight Deck overhead speaker to alert the crew to an incoming interphone call from the ground engineer.





POWER SUPPLY

DC ground service bus C/B 2L2 MECH CALL.

CABIN/GALLEY INTERPHONE

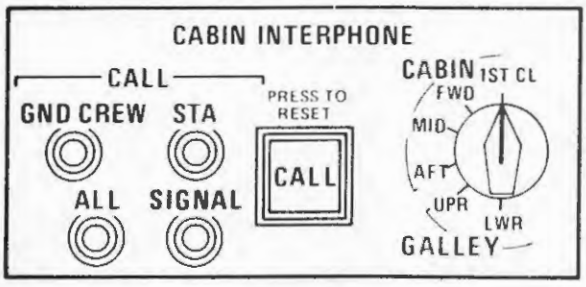
INTRODUCTION

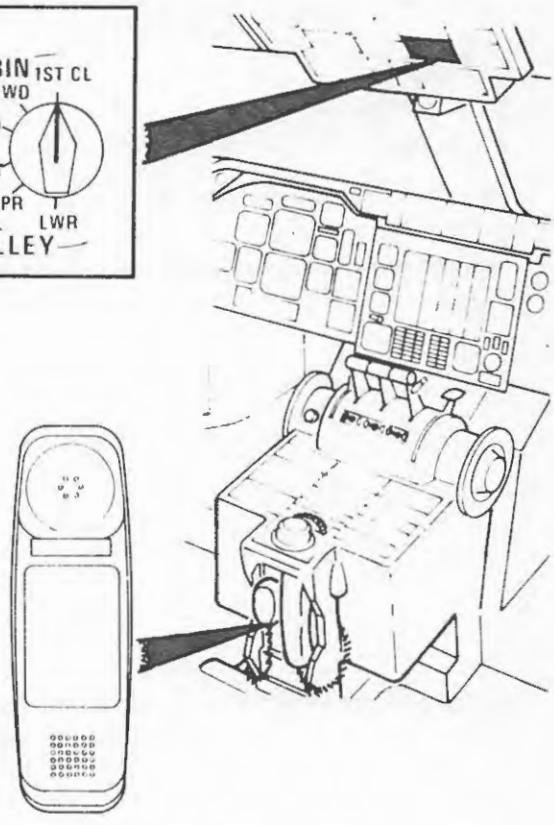
There are two separate systems. Cabin interphone provides a party line system between the flight station and ten cabin/galley positions.

Galley interphone provides for communication between the lower galley and three cabin positions.

DESCRIPTION

In the flight deck on the Pilot's overhead panel is located a Cabin Interphone control panel.



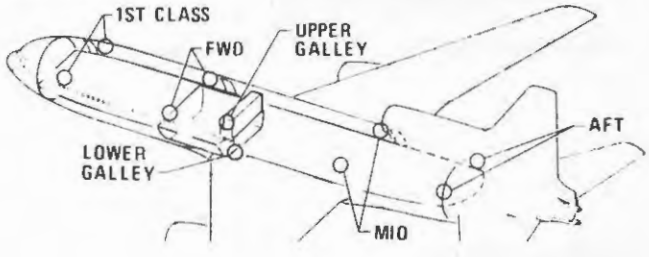


On the rear of the centre console is a handset.

CABIN INTERPHONE PANEL STATION SELECTOR

The Station Selector Switch is a six-position rotary switch that selects the cabin or galley station to be called.

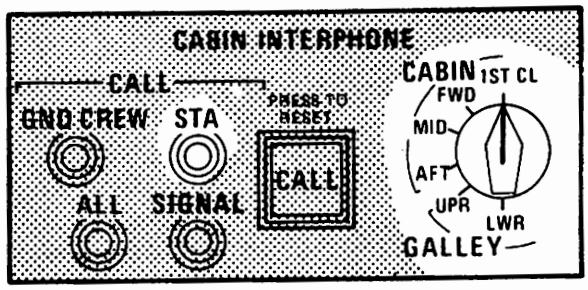
The placarded positions represent the stations.



OPERATION

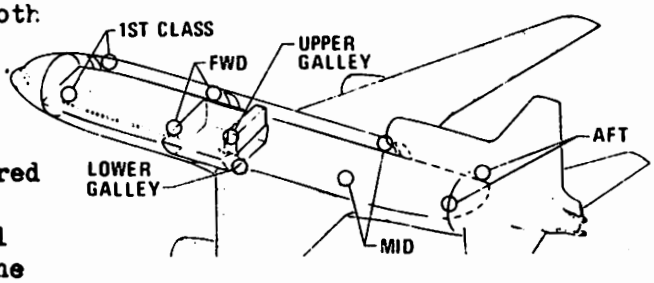
AREA SELECTOR AND STATION SWITCH

To call any given area in the cabin or galley, lift up the handset, select the area and press the STA switch. Each area has an interphone handset and call light.



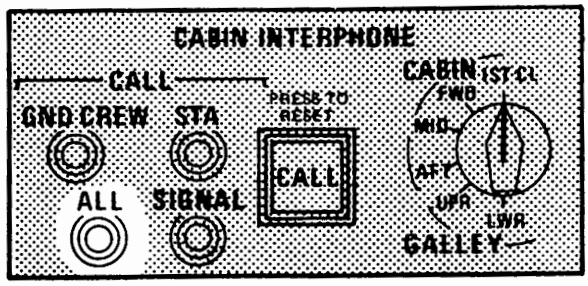
PINK CALL LIGHT FOR CABIN INTERPHONE
GREEN CALL LIGHT FOR GALLEY INTERPHONE

A chime will sound and call light come on at both phones representing the area called, except the upper and lower galleys which are independent. When your call is answered press the PRESS TO TALK switch. When your call is completed, hand up the handset. This will reset the system like a standard home telephone. This is a party line system. Once in use any one can pick up a handset and listen in.



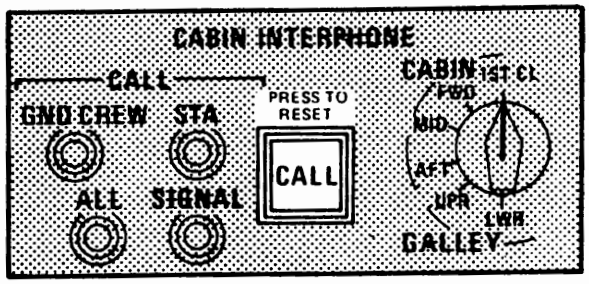
ALL CALL

If you wish to call all stations at the same time, lift up the handset and press the ALL switch. Each cabin and galley station will hear three consecutive HI/LO chimes and the call lights will illuminate. When all stations have answered, proceed with the conference call.



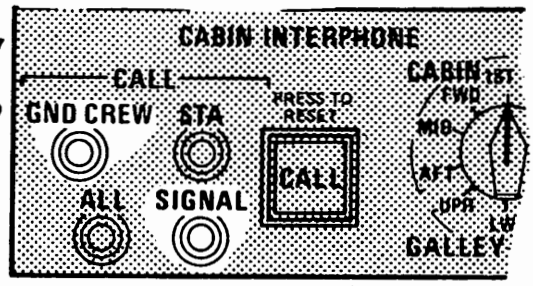
CALL LIGHT

A call to the cockpit will turn on the CALL light and sound a chime. Pick up the handset and answer as you would with a regular telephone. The call light will go out. If another call is made to the cockpit, the new call will simply break in. The call light also provides a reset function which allows you to HANG UP without actually placing the handset back in its cradle.



SIGNAL AND GROUND CREW CALLS

The signal switch sounds a HI chime in the cabin and may be used as a signal device. The GND CREW causes a horn to honk at the nose wheel location. Flight Int would be used to communicate with the ground crew.



ATTENDANT HANDSET

Each Cabin Attendant Station has a handset, a call light and a chime. A rotary thumb wheel allows selection of the station to be called. The Call Switch is pressed to initiate a call.

GALLEY INTERPHONE

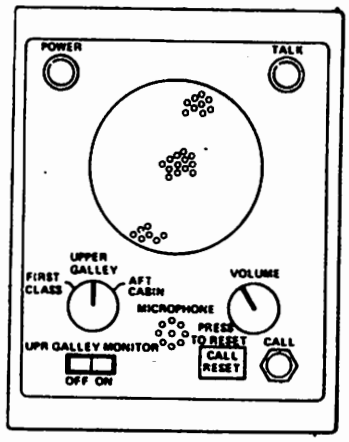
This system allows communication between three cabin positions and the lower galley.

DUAL HANDSET

The three cabin dual handsets are located at the forward left door, the upper galley and the aft right emergency exit. Calls made to the lower galley through these Dual Handsets go to ceiling mounted speakers in the lower galley.

GALLEY INTERPHONE PANEL

A slide switch allows the selection of either the cabin or galley interphone. The galley attendant can answer calls by pressing a PUSH TO TALK switch on a speaker microphone, located between the galley lifts. The galley can also initiate calls through the galley interphone system to any of the three dual handsets. The cockpit cannot call into this galley interphone system.



GALLEY MONITOR

An open mike from the upper galley to the lower galley is also provided. The lower galley can turn this mike on in order to hear cabin sounds. It is one-way to the lower galley only.

POWER SUPPLIES

DC ground service bus. C/B 2L7

SERVICE INTERPHONE

INTRODUCTION

Jack points are provided at major servicing areas throughout the aircraft to provide a communications link during ground servicing.

The system interfaces with the flight crew audio selector panels to increase the available coverage.

CONTROL

A switchlight is located on the P3 mic selection panel on the lower left - below table level - on the systems station.

This must be latched in to provide the flight crew with service interphone facility.

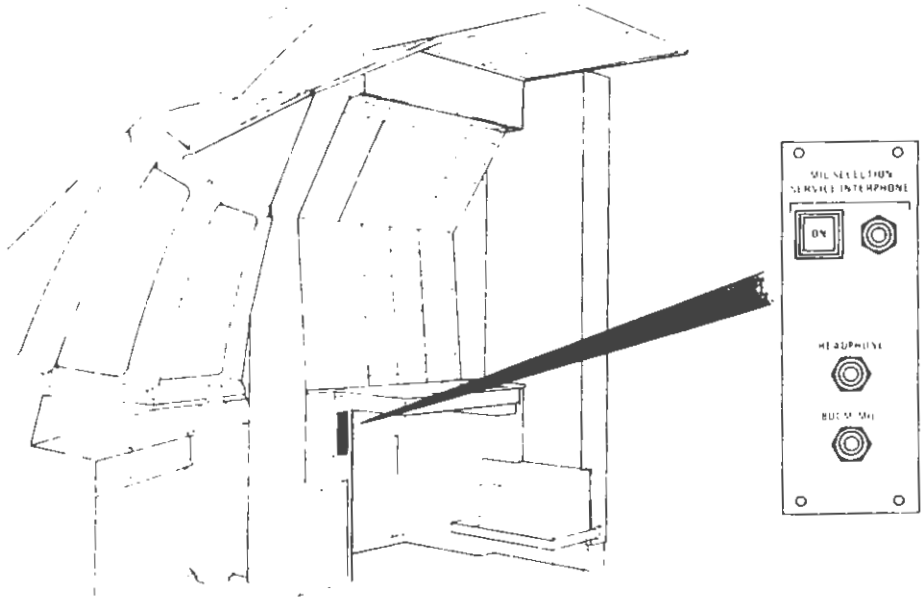
An interface between cabin and galley interphone system and the service interphone is available if both systems are powered.

Thus with all three systems powered a multi-position party line between all internal and external communications points is available.

If the normal flight interphone fails, this service interphone may be used as a flight interphone system. By tripping the cabin interphone C/B and leaving the switchlight OFF, it would render the system private to the flight deck and avoid party line interruptions.

POWER SUPPLY

DC ground service bus. C/B 2L1



PASSENGER ADDRESS

INTRODUCTION

A PA system provides for announcements to be made from the flight deck or from the cabin attendants' positions to the passengers. A panel at the forward cabin attendants' position also provides for any one of 24 pre-recorded announcements from a tape reproducer to be selected.

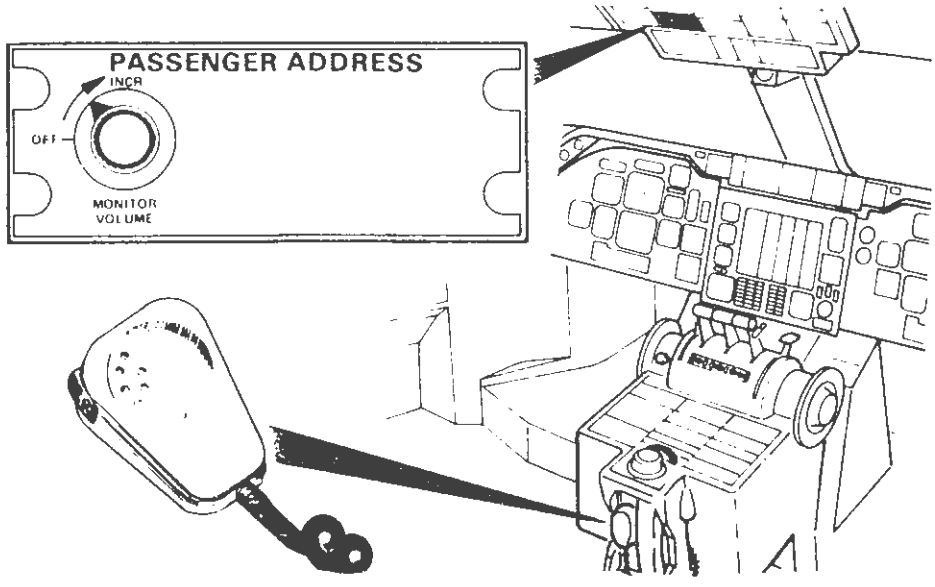
OPERATION

From the flight deck, announcements may be transmitted by using either

a hand microphone,
the boom microphone,
the oxygen mask microphone.

PA PANEL LOCATION

The Passenger Address MONITOR PANEL is located on the Pilot's Overhead Panel. The Passenger Address Hand Mike is located aft of the centre console.



PA MONITOR

Passenger Address Announcements made by cabin attendants can be monitored through the cockpit monitor panel and speaker. Inputs to the speaker are controlled with the monitor volume control switch. Nothing can be heard with this switch in the OFF position. Remember as long as either the Battery or essential Master Radio switch is ON the Passenger Address system is active.

To use either the boom or oxygen mask microphone, select MASK or BOOM on the switch on the audio selector panel. Depress mic select PA button and audio select PA button on the audio selector panel.

A flight deck selection will override a cabin selection.

POWER SUPPLIES

Ess. Radio master switch ON.
C/B's PA1. 1A15. PA2. 1A16

INTRODUCTION

Two VHF Transeivers are fitted for communication over the frequency range 118.00 to 135.975.

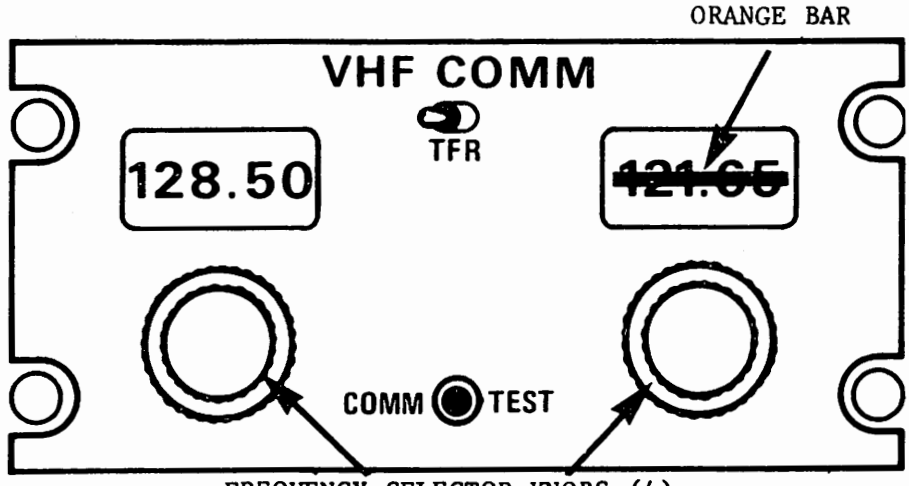
CONTROLLERS

Located on the centre pedestal.

Dual indicating windows and dual frequency selecting knobs are fitted to EACH controller with a TRANSFER switch. The frequency for current use is selected in one window with the transfer switch selected to that side. The next frequency to be required is pre-selected in the other window and will be crossed out by an orange bar. When the new frequency is required, the TRANSFER switch is operated to that side and the bar transfers away from the newly selected frequency window to re-appear on the old frequency no longer in use.

A COMM TEST button on the controller when pressed removes the squelch and the background noise rises to indicate the receiver is "live".

No provision is made for operating with the squelch permanently off.



FREQUENCY SELECTOR KNOBS (4)

Outers - Whole MHz 118 - 135
Inners - Decimal part .00-.02-.05-.07-.10

AERIALS

VHF 1 aerial is located towards the forward end on top of the fuselage and is de-iced by hot air to avoid shedding of large chunks of ice into the centre engine intake. VHF 2 aerial is underneath the fuselage towards the centre.

VHF 1 will provide best results with the aircraft on the ground and VHF 2 when airborne.

POWER SUPPLIES

VHF 1 is supplied either by the ESSENTIAL DC BUSBAR or by the BATTERY BUSBAR. The ESSENTIAL RADIO MASTER SWITCH must be ON but the battery switch may be ON or OFF. It can therefore be used when the aircraft is being towed.

VHF 2 is supplied by the DC GROUND SERVICE BUSBAR and does not require the MASTER RADIO SWITCHES to be ON.

CB's	VHF 1.	1A11
	VHF 2.	2L4

H.F. COMMUNICATIONS

INTRODUCTION

The HF system provides for long range radio transmission and reception over the full frequency range of 2.000 to 29.999 MHz. Both amplitude modulation (AM) and single sideband (SSB) modes are available. The use of upper sideband (USB) is conventional and, compared to AM, will result in greater irtelligibility and less receiver noise where the ground station is suitably equipped.

EQUIPMENT

The system comprises:-

TRANSCEIVER UNIT
REMOTE DUAL CONTROLLER
AERIAL COUPLING UNIT

The airframe is used as the aerial and is energised by an aerial coupling conductor strip in the leading edge of the vertical stabiliser.

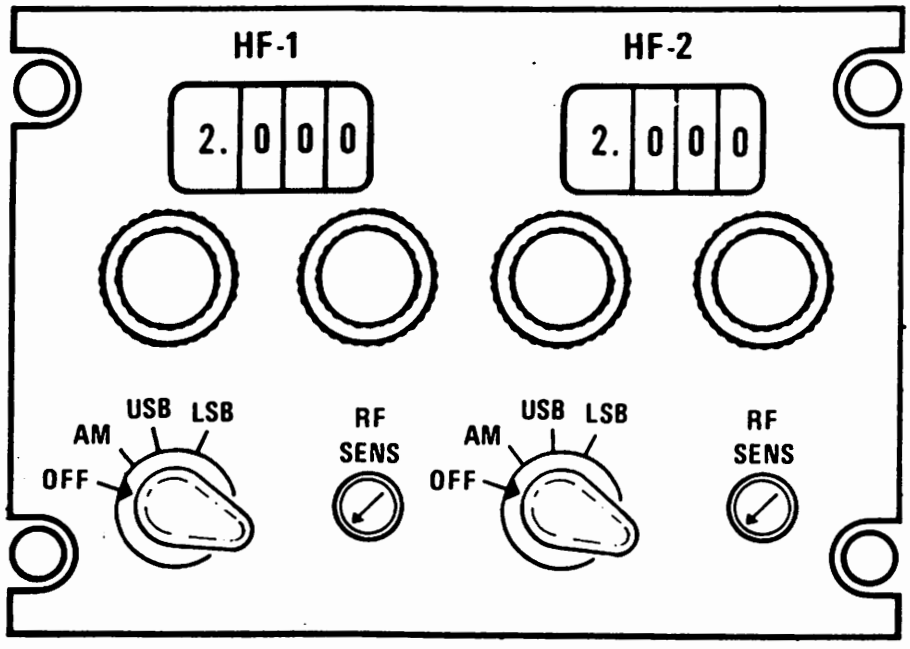
DUAL CONTROLLER

This is mounted on the upper right side of the overhead panel with the left hand half used for HF 1 control. Frequency selector knobs and a digital read out provide for selection of the operating frequency in 1 KHz increments over the full range of 2.000 to 29.999 MHz.

The function switch is marked

OFF - AM - USB - LSB

and controls the power supplies and the operating mode. There is also an RF gain control marked RF SENS.



TUNING

To achieve maximum frequency stability the equipment should be switched ON to warm up for at least 5 minutes.

Channel selection time is about 8 seconds.

When the transmit switch is pressed, automatic tuning of the aerial circuits takes place and a 1KHz tone will be heard in the headset. This takes about 5 seconds and its completion is indicated by the tone going off.

OPERATION

DO NOT TRANSMIT WHILE AIRCRAFT IS BEING FUELED

DO NOT TRANSMIT ON USB OR LSB WHEN ANOTHER AIRCRAFT IN RECEIVE MODE IS WITHIN 250 FEET

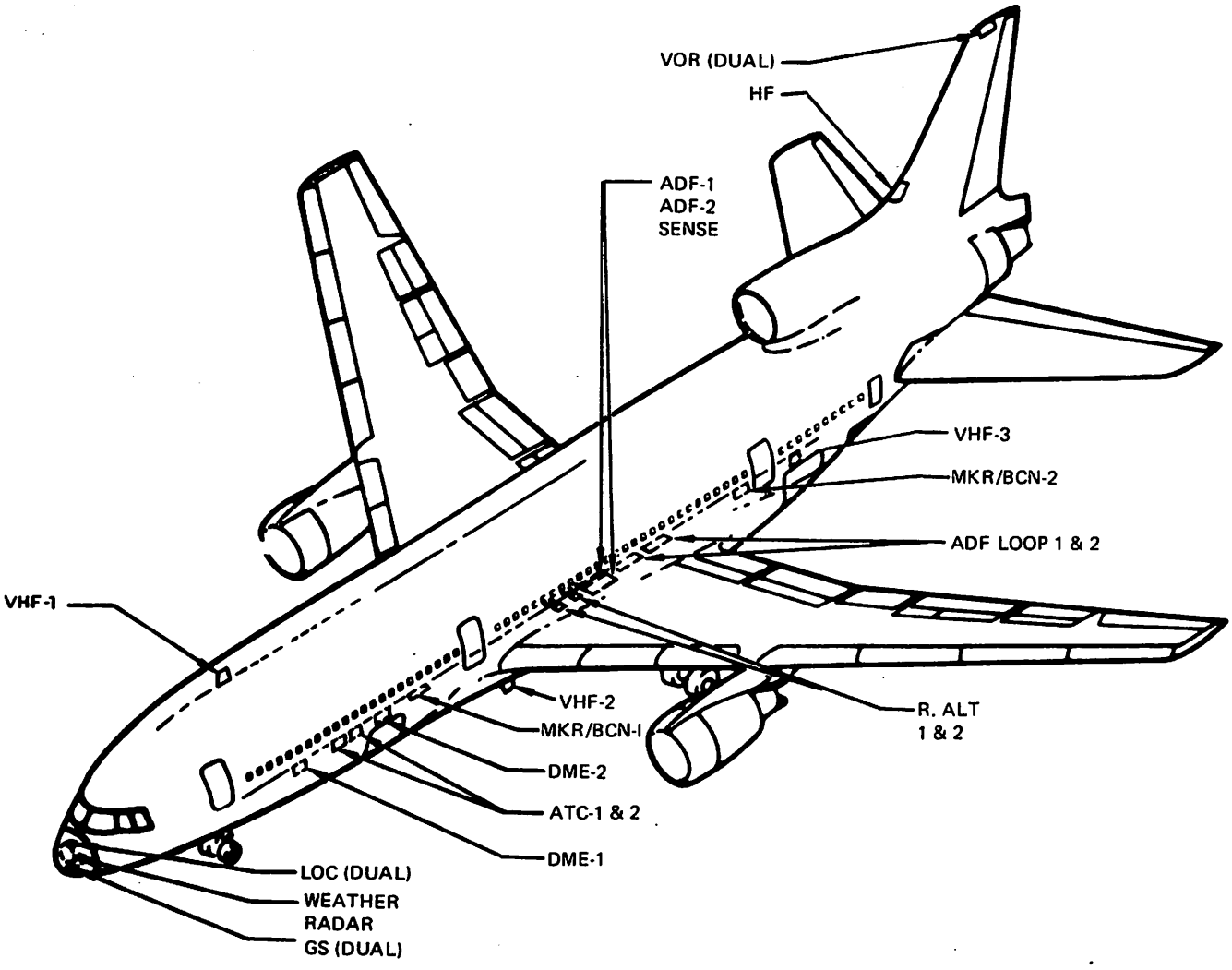
(i) Master Radio Essential Switch ON
(ii) Controller switch to desired mode. Allow 5 minutes warm up time.
(iii) Microphone selector switch to BOOM
(iv) On audio selector panel depress HF 1 audio selector and rotate for desired volume.
(v) On controller set up test station frequency in the window.
(vi) Listen out for a clear channel.
(vii) On audio selector panel depress HF 1 microphone selector button.
(viii) Operate PTT switch and listen until 1 KHz tone ceases.
(ix) Establish contact with test station and check:-

(a) Satisfactory report from ground station
(b) Satisfactory reception of ground station
(c) Sidetone is present in headset.

POWER SUPPLIES

ESS RADIO DC BUS 1C 1
ESS RADIO AC BUS 1C 3

AERIAL LOCATIONS



VHF NAVIGATION

INTRODUCTION

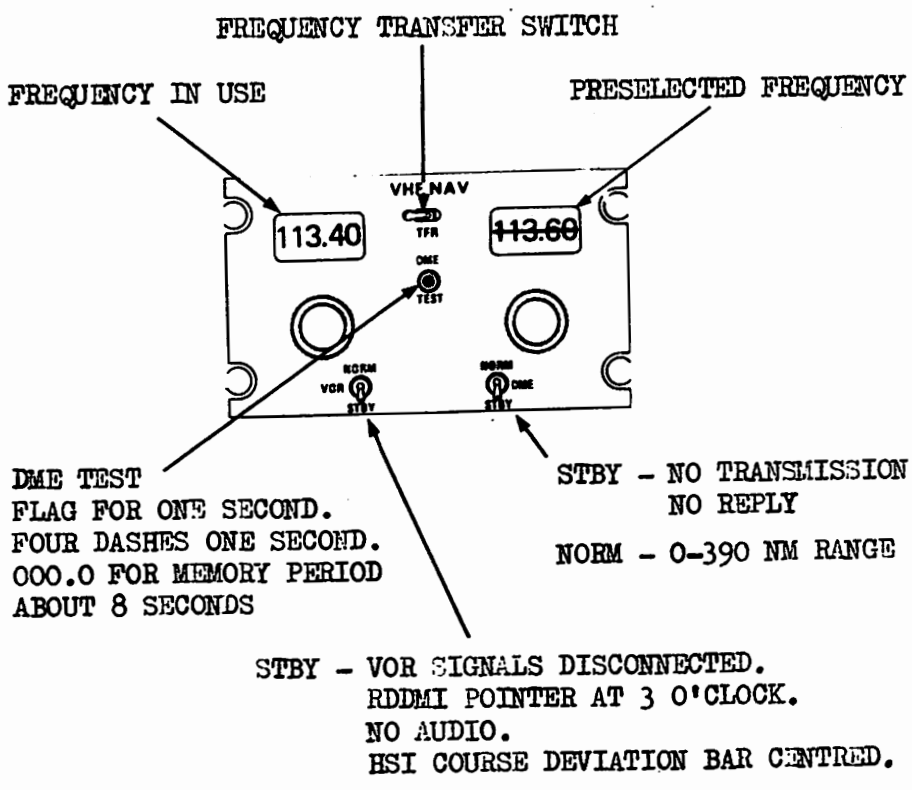
The system is designed to be compatible with Category 3 landing requirements. The ILS receives and processes localiser and glide slope signals to operate deviation displays and to supply inputs to the Auto Pilot Flight Director System (APFDS) computors.

Two independent VHF NAV systems are provided with a frequency range of 108.0 to 117.95 MHz.

The VHF NAV controllers are located on the centre console and provide for frequency selection and logic control of separate ILS localiser and glide path receivers and also separate VOR and DME equipments.

Twin tuning heads are provided with a transfer switch for rapid change to a previously pre-selected second frequency.

CONTROLLER



IIS

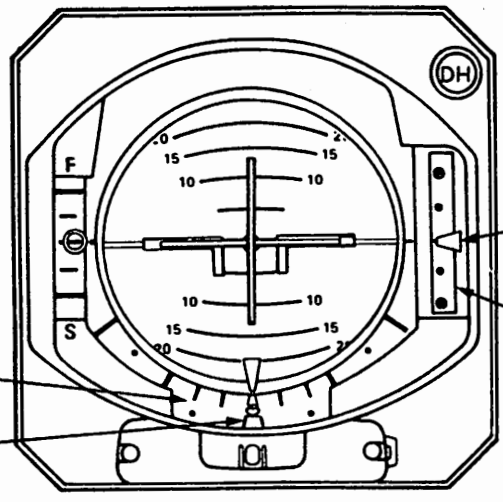
The localiser and glide path receivers process received signals and feed outputs to deviation displays and flag circuits in the Attitude Director Indicator (ADI) and the Horizontal Situation Indicator (HSI). Outputs are also supplied to the Autopilot Roll and Pitch computors as guidance signals for automatic landing.

Two systems are provided :- IIS 1 for the Capt's ADI and HSI.
IIS 2 for P2's ADI and HSI.

IIS 2 also provides localiser deviation signals to the PVD for roll out and take off guidance.

Localiser audio is available on the NAV positions on the Audio Select panels.

ATTITUDE DIRECTOR INDICATOR



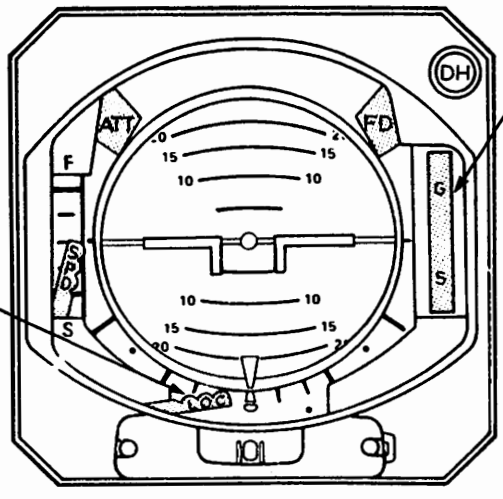
GLIDESLOPE DEVIATION POINTER

GLIDESLOPE DEVIATION SCALE

LOCALISER DEVIATION SCALE

LOCALISER DEVIATION POINTER

A.D.I. WITH FLAGS



GLIDESLOPE FLAG

COVERED BY GLIDESLOPE SCALE IF :-

LOC FREQ TUNED, AND GLIDESLOPE VALID, AND SENTRI AMPL VALID, AND POWER SUPPLY VALID.

COVERED BY BLACK SHUTTER IF :-

VOR FREQ TUNED, AND SENTRI AMPL VALID, AND POWER SUPPLY VALID

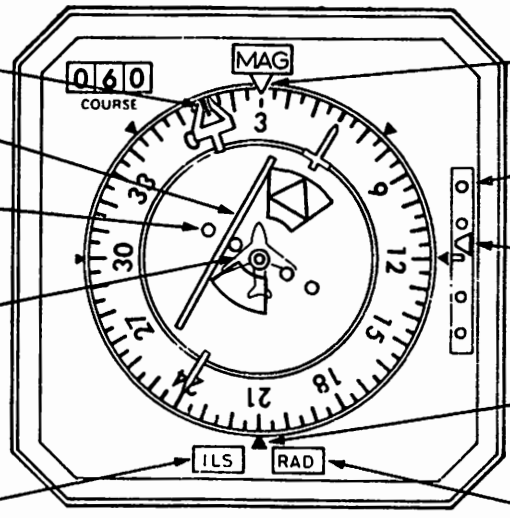
LOCALISER FLAG

MONITORS LOCALISER VALID IF LOC FREQ TUNED

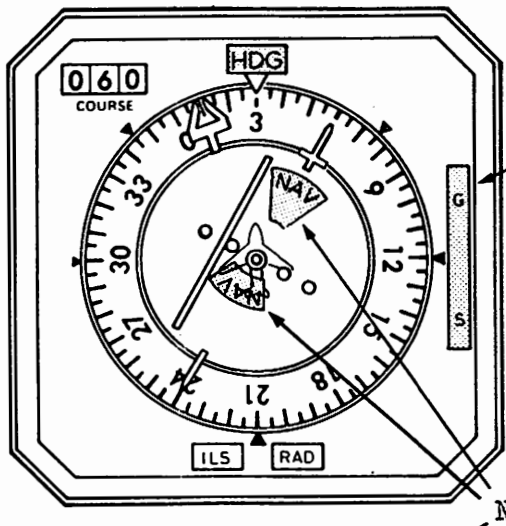
MONITORS SENTRI AMPL VALID.

MONITORS POWER SUPPLY.

HORIZONTAL SITUATION INDICATOR



HSI WITH FLAGS



FAIL MONITORING

When a VOR frequency is selected on the controller, the ILS localiser and glide slope deviation signals are disconnected from the HSI and the VOR outputs displayed. The localiser flag on the ADI is biased out of view and the glide slope scale is covered by a black shutter.

The HSI NAV failure flag will monitor the VOR signals with VOR selected and ILS signals on ILS.

A navigation source annunciator on the HSI will indicate the source of information - ILS or VOR.

With a failure of ILS 1 the P1 HSI may be transferred to ILS 2 by operation of the alternate deviation switchlight. Similarly P2 may transfer his HSI to ILS1. Only one DEV switchlight may be operated and it removes the supply so that the other side is inoperative.

AERIALS

Dual localiser and glide slope aerials are mounted in the nose radome.

POWER SUPPLIES

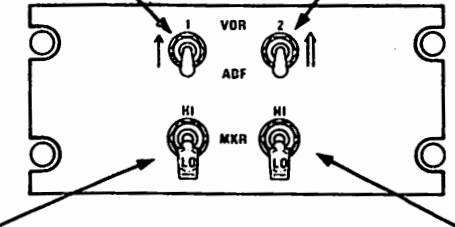
Power supplies to ILS1 and ILS2 are independent of radio master switches.

ILS1. AC STANDBY BUS 1G4
ILS2. AC BUS 2 EXTN. 1G22.

VOR/ADF SELECT PANEL

NO. 1 VOR ADF SELECTOR
Selects VOR1 or ADF1 for display.
Controls No. 1 pointer of both RDDMI's.

No. 2 VOR ADF SECTOR
Selects VOR2 or ADF2 for display.
Controls No. 2 pointer fo both RDDMI's.



NO. 1 MARKER BEACON SENSITIVITY SWITCH

NO. 2 MARKER BEACON SENSITIVITY SWITCH

VOR

The VOR receivers have pre-amplifiers incorporated in the aerial circuit to compensate for the signal loss between the dual aerial in the tip of the vertical stabiliser and the receivers in the FESC.

Failure of a pre-amplifier will cause a loss of signal strength. If the VOR PRE-AMP C/B is tripped then signals will be restored with only a slight reduction in operating range.

A VOR/ADF select panel on the centre pedestal allows either VOR or ADF signals to be fed to the single and double pointers of the RDDMIs.

Outputs from VOR1 are also fed to the P1 HSI:-

VOR deviation to the course bar.
TO/FROM signals to the indicator arrow.
Valid signals to keep the NAV fail flag out of view.

Deviation and VOR valid signals are also supplied to the AFCS Roll Computor 1.

Outputs from VOR2 are similarly fed to P2. HSI and AFCS Roll Computor 2.

By depressing the Instrument Source Select DEV switchlight on the P1 or P2 instrument panels, information to the HSI may be obtained from the opposite VOR but only one of them may be selected and will inhibit selection of the other alternate DEV.

On the NAV MODE panel if the SPLIT-VOR1-VOR2 switch is moved from its normal split position, then either VOR1 or VOR2 will feed both Roll computors.

AUDIO

VOR audio is available at the NAV positions on the Audio Select panels but is routed through the VOICE-BOTH-RANGE switch. Normally BOTH will be selected. If an ATIS or weather voice transmission is being copied then select VOICE to attenuate the coded call sign. If only the call sign is required and not the voice transmission then select RANGE. Note that the DME identification is completely suppressed with the switch at VOICE.

VOR MONITORING

With a VOR signal failure the NAV fail flag on the associated HSI will come into view and the VOR fail flags on both RDDMIs will also come into view. The appropriate pointers on the RDDMIs will go to the 3 o'clock position. Note that the VOR fail flags on the RDDMIs are both coloured red and are NOT colour coded red and green to associate them with the pointers.

The navigation source annunciator on the HSI will indicate the source of information - VOR - but if the VOR power supply is lost it will revert to ILS - the unpowered condition.

POWER SUPPLIES

VOR power supplies are independent of radio master switches.

VOR 1 Receiver	DC S/B BUS 1G1
VOR 1 Pre-amp.	DC S/B BUS 1G2
VOR 1 26v excitation	AC S/B BUS 1K21
RDDMI.1.	AC S/B BUS 1K20.
VOR 2 Receiver	DC BUS 2 1G19
VOR 2 Pre-amp.	DC BUS 2 1G20
VOR 2 26V excitation	AC BUS 2 1J22
RDDMI.2.	AC BUS 2 1J20

VHF NAV (MARKERS)

INTRODUCTION

Two marker receivers are fitted to provide visual and aural warning of outer, middle and airways markers independently to P1 and P2. Separate aerials are mounted along the centre line under fuselage.

OPERATION

As the aircraft flies over a marker beacon the 75 MHz signal is received by both receivers. Depending upon which marker is being received, the signal is filtered out by either the 400, 1,300 or 3000 Hz detector and fed to the blue outer, amber middle or white airways marker lamps on the instrument panels. Each lamp is a Press-to-test type deriving its test supply through its own receiver power supplies.

HI/LO sensitivity switches are located on the centre pedestal.

POWER SUPPLIES

Are dependent upon Master Radio Switches

MKR 1	DC ESS RADIO BUS	1D7
MKR 2	DC BUS 2	1D25

D.M.E.

INTRODUCTION

A dual system provides display of the slant range from the aircraft to a selected DME beacon. Both DME 1 and DME 2 have distance read-outs on both left and right RDDMIs.

CONTROLLER

Selection of the paired VOR frequency also selects the DME channel from the appropriate VHF NAV controller. See illustration.

NORM STBY SWITCH

When selected to NORM, interrogations are transmitted and replies from the beacon received and displayed.

With STBY selected, the receiver is operating but no transmissions are going out and the distance indicators will display four dashes.

RANGE

The available range is 0 to 390 NM dependent upon aircraft altitude. At FL400 maximum range is about 260 NM.

AUDIO

The DME call sign can be heard in the headset with the appropriate NAV 1 or NAV 2 button selected in, on the AUDIO SELECT PANEL. If the VOICE-BOTH-RANGE switch is selected to VOICE, the DME call sign is suppressed so that ATIS or weather on the VOR channel can be copied with a weak VOR ident in the background.

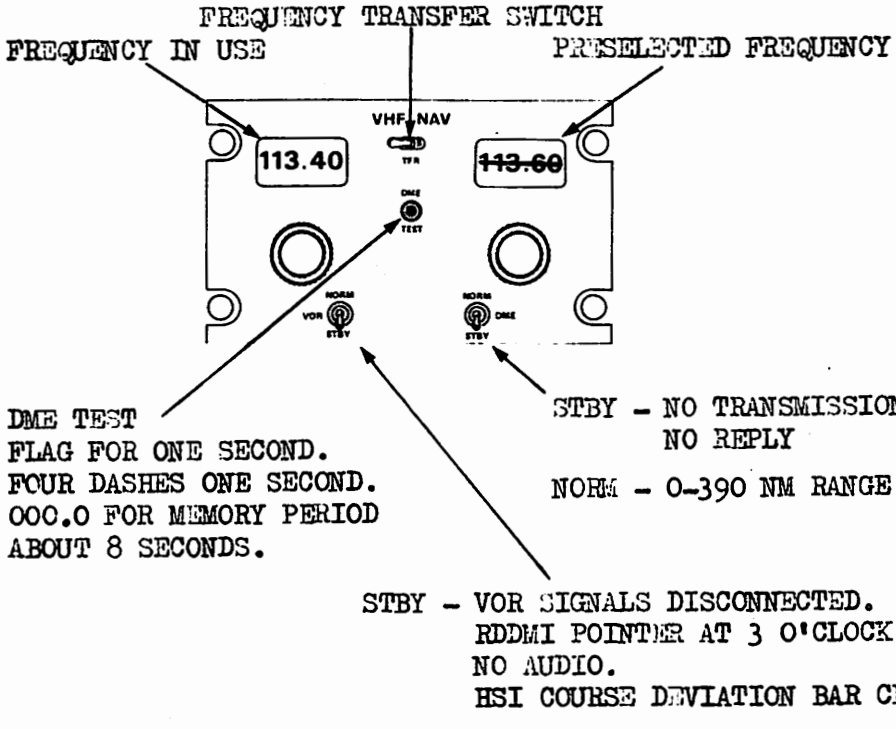
AERIALS

One for each system on the forward lower fuselage centre line.

POWER SUPPLIES

MASTER RADIO SWITCHES ON

DME 1	ESS AC BUS	1D5
DME 2	AC 2 RADIO BUS	1D23



A.D.F.

INTRODUCTION

Two separate ADF systems are fitted, each one supplying bearing information in parallel to the left and right RDDMIs. The red pointers are shared with VOR 1 and the green pointers with VOR 2. Switching is by ADF/VOR switches on the centre pedestal. The controllers are mounted one on each side of the centre pedestal. The frequency range is 190 to 1750 KHz in 0.5 KHz increments.

CONTROLLERS

Although the frequency selecting knobs will permit figures to be displayed in the window between 100 and 1799.5, only the range

190 to 1750 KHz

may be used for ADF purposes.

Illustration shows the controls.

AERIALS

Two flush, fixed loops are mounted along the lower aircraft centre line with No.1. forward of No.2. The sense aerials are flush panels located outboard of the loops with No.1. on the left and No.2. on the right.

RDDMI ANNUNCIATORS

The source of bearing information is displayed on the bottom corners of the RDDMIs by a V, an A, or black and blank.

With the ADF/VOR switch selected to ADF and the ADF/ANT switch on the ADF controller at ADF then A will be displayed. If ANT is selected on the controller the annunciators will show blank.

VOR FAIL FLAGS RDDMI

These have no function with ADF selected and are biased out of view. If they are in view with ADF selected, check ADF power supply.

TEST PUSHBUTTON

This provides for self-test of the system. When depressed and held, an audio tone sounds in the headset and the selected RDDMI pointers will swing to 315 degrees RELATIVE.

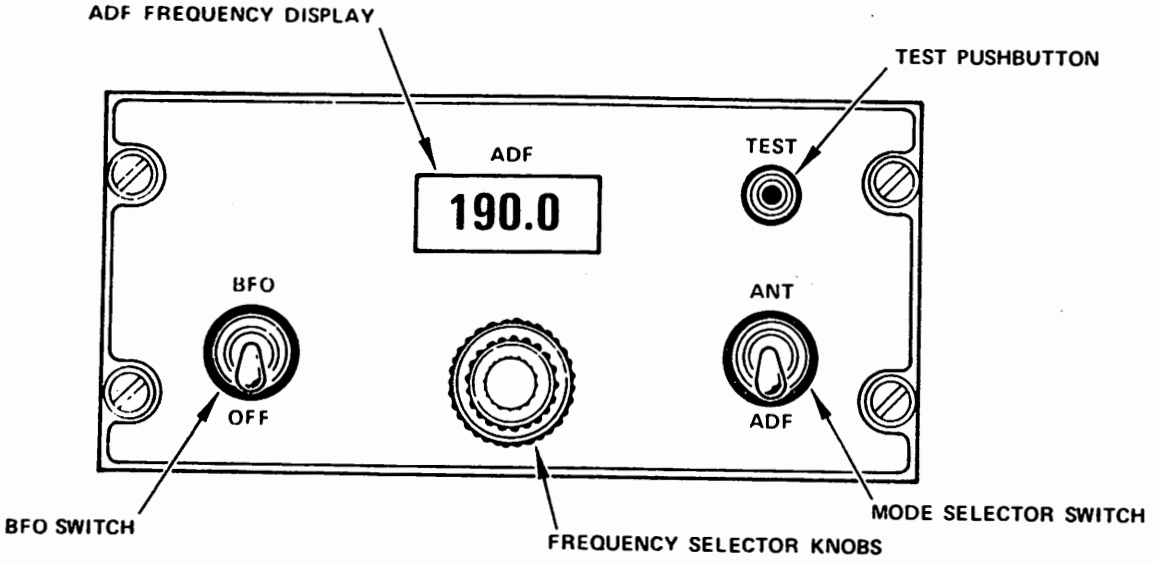
POWER SUPPLIES

ADF 1 is independent of any master radio switches.
ADF 2 is via the No.2. MASTER RADIO switch.

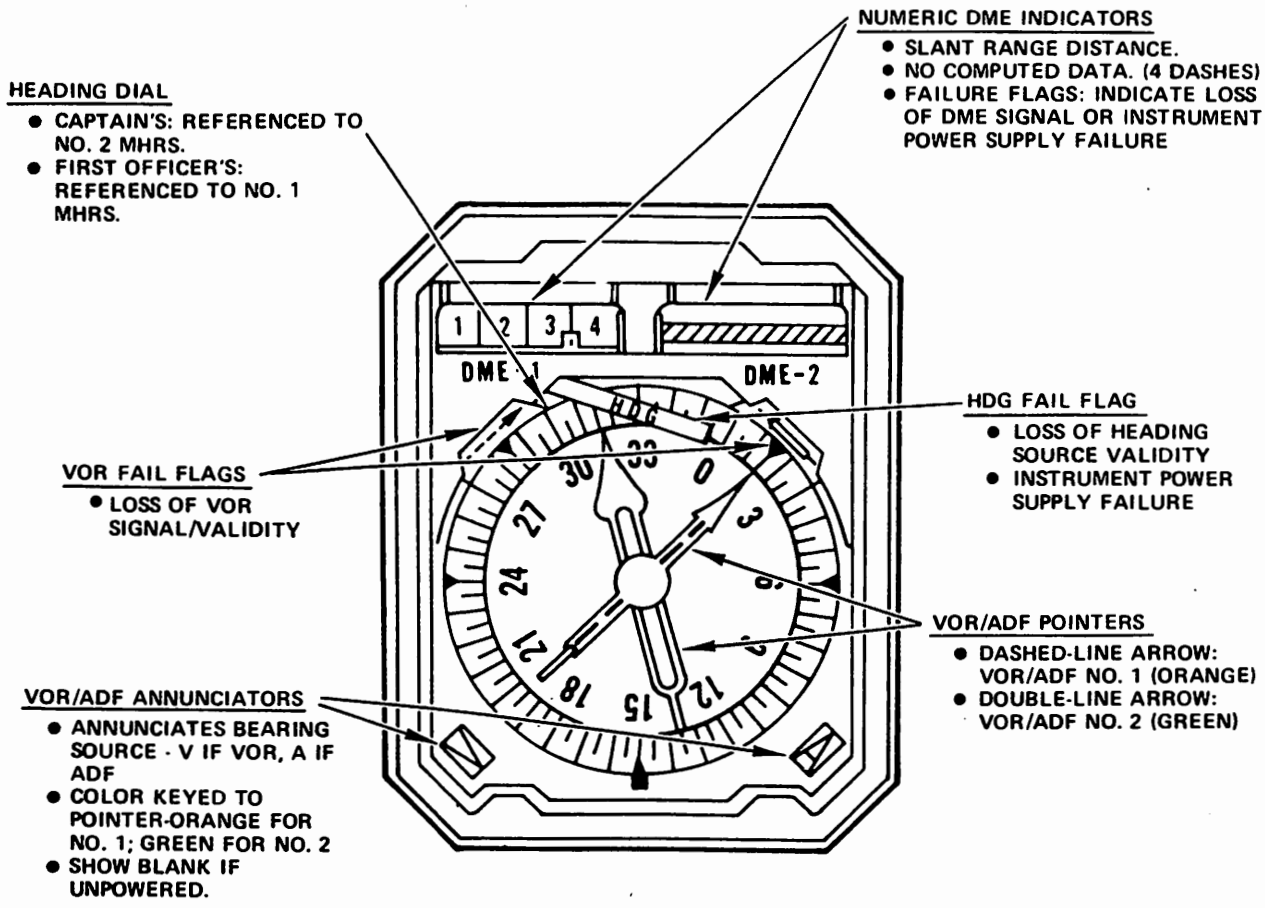
ADF 1	DC	STANDBY BUS	1G9
RDDMI 1	AC	STANDBY BUS	1K20.
ADF 2	DC	BUS 2.	1D24
RDDMI 2	AC	BUS 2 EXT.	1J20

When only DC Standby and AC Standby power supplies are available from the battery and static inverter (no other busbars powered), the RDDMI compass cards are "frozen" and relative bearings against the fixed outer scale markings are available. The annunciators will indicate normally.

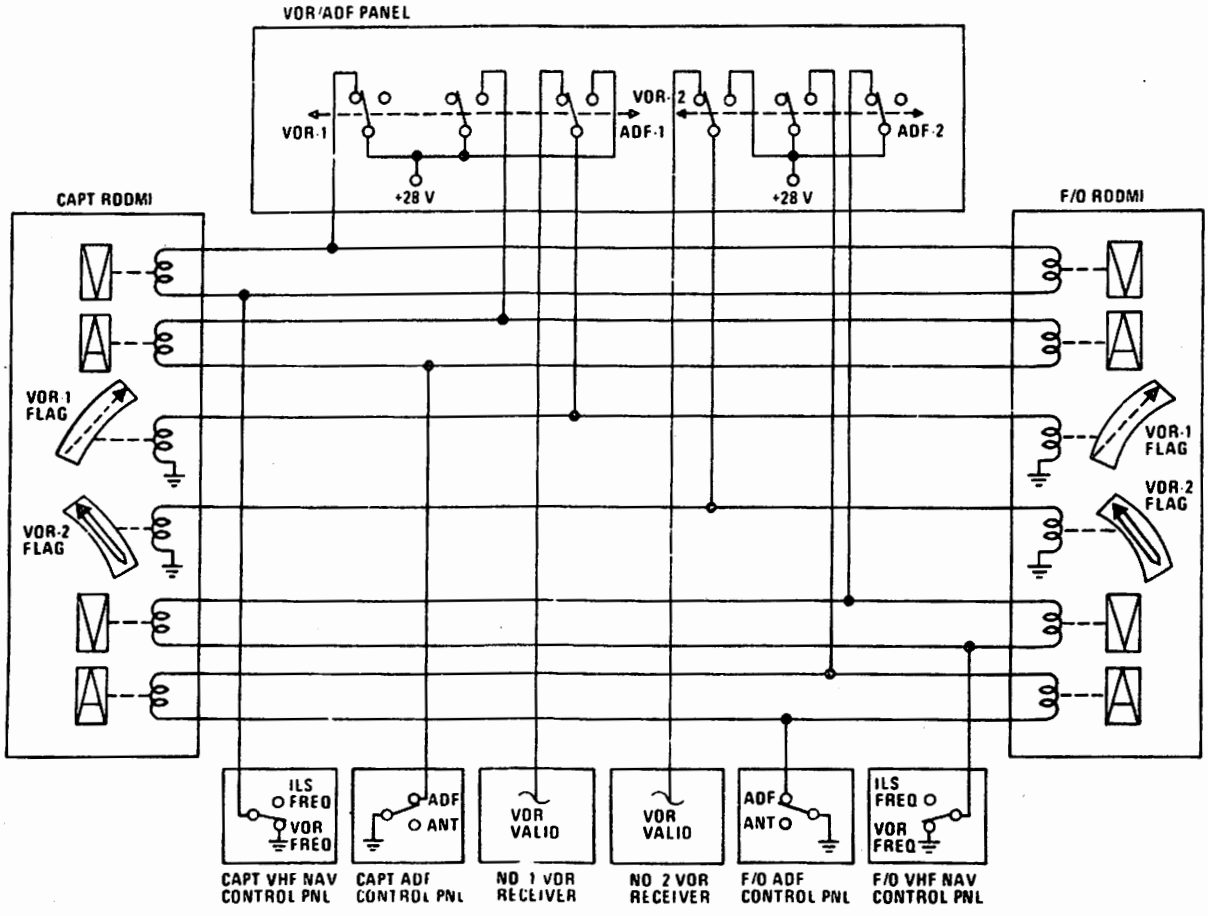
ADF CONTROL PANEL



RADIO DIGITAL DISTANCE MAGNETIC INDICATOR



RDDMI ANNUNCIATOR AND FLAG SWITCHING



A.T.C. TRANSPONDER

INTRODUCTION

The purpose of the system is to identify the aircraft and its position through coded replies to ground station interrogation. Coded aircraft altitude will also be transmitted if interrogated in Mode C.

DESCRIPTION

Two independent transponders are fitted, each with its own aerial. A dual control unit allows selection of the operating unit with the other one at standby.

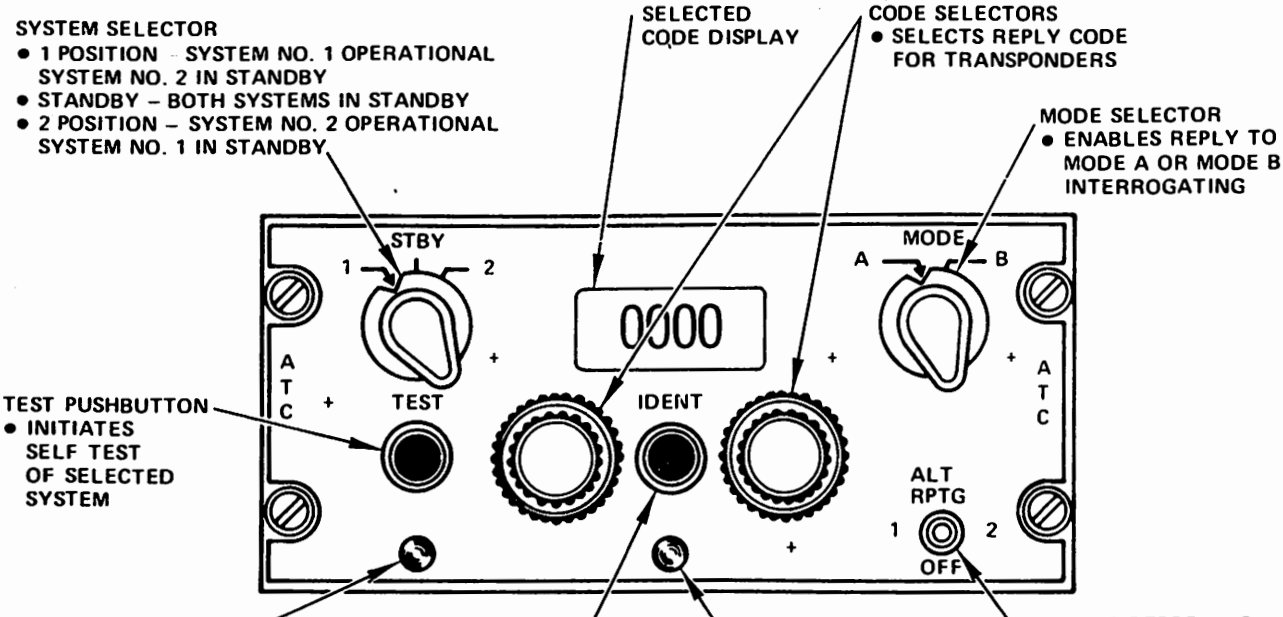
CONTROLLER

A dual controller is located on the centre pedestal. See illustration for control functions.

POWER SUPPLIES

For the number one system the supply is independent of the Radio Master switches. For the number two system the No.2. Master Radio switch must be ON.

ATC Tx 1	AC	STANDBY	1G3
ATC Tx 2	AC 2	RADIO	1G21.



ATC DUAL CONTROL PANEL

WEATHER RADAR

INTRODUCTION

The primary function of the system is to provide visual indication of the intensity of storm clouds in the vicinity of the aircraft.

Its secondary function is map painting of the terrain.

DESCRIPTION

There are two independent Receiver-Transmitter systems. A dual controller allows selection of one system for operation with the other system at standby. Two indicators are connected to the operating system. One for P1 and one for P2 on their respective side panels.

Radar Scanner

A 30 inch flat plate is used covering an arc of 180° ahead of the aircraft with a complete scan every 4 seconds. The beam width is 2.7° on the weather search mode and a broad fan beam in mapping. 15° of up or down tilt is available.

Stabilisation, with limits of ± 40° in roll and ± 25° in pitch is provided by:-

VG1 for System 1.
VG2 for System 2.

Indicator

See illustration for control functions.

Controller

A dual controller is located on the centre pedestal and within reach of P1, P2 and P3. See illustration for control functions.

TEST

A test pattern can be displayed on the indicators to check the system.

FAULT LAMPS

Faults which arise in the operating system are indicated by fault lights on the controller. One lamp for the Antenna (ANT) and one for the Receiver-Transmitter (RT).

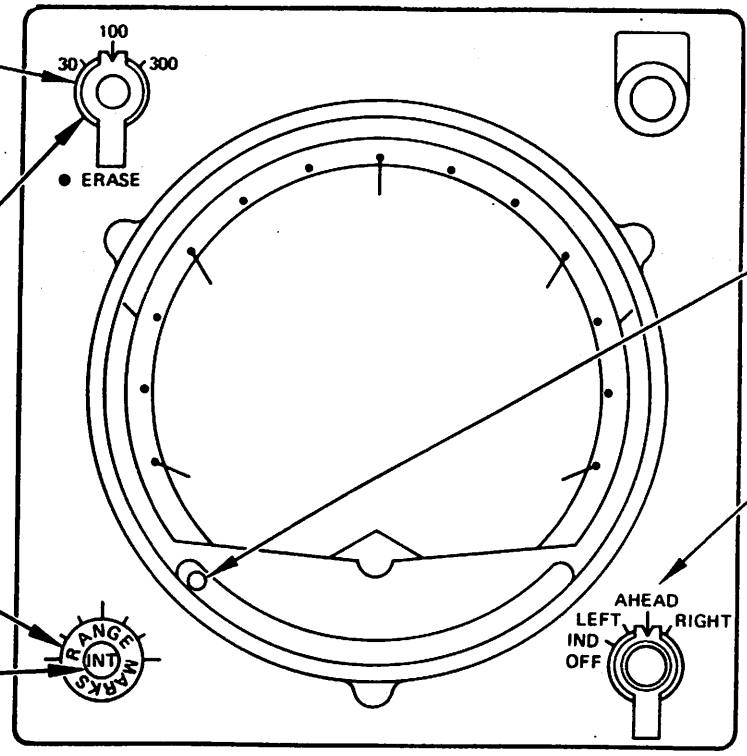
If the fault lights come on in flight, the other system should be selected. If this does not clear the fault lights, switch off.

POWER SUPPLIES

Both Radio Master switches ON.

Radar Indicator 1.	AC ESS.	1D2
Receiver-Transmitter 1.	AC ESS.	1D3
Radar Indicator 2.	AC 2. EXT.	1D20
Receiver-Transmitter 2.	AC 2. EXT.	1D21

WEATHER RADAR INDICATOR



RANGE SELECTOR

30 - RANGE MARK AT 25 NM

100 - 4 RANGE MARKS AT 25 NM INTERVALS

300 - 6 RANGE MARKS AT 50 NM INTERVALS

ERASE PUSHBUTTON

PERMITS RAPID ERASURE OF ENTIRE DISPLAY

POLARIZING FILTER CONTROL

FULL LEFT- BRIGHT DAYLIGHT DISPLAY.

FULL RIGHT- DEEP RED FOR NIGHTTIME VIEWING-

INDICATOR CONTROL

IND OFF
TURNS OFF INDICATOR ONLY.

LEFT
SWEEP APEX IS OFFSET TO RIGHT.

AHEAD
SWEEP APEX IS CENTERED.

RIGHT
SWEEP APEX IS OFFSET TO LEFT.

RANGE MARKS CONTROL

VARIES INTENSITY OF RANGE MARKS

INT CONTROL

VARIES INTENSITY OF RETURN VIDEO

WEATHER RADAR DUAL CONTROL PANEL

MODE SELECTORS

OFF - BOTH SYS OFF.

STBY - INITIATES 3-1/2 MINUTE WARMUP.

NORM - WEATHER SEARCH MODE.

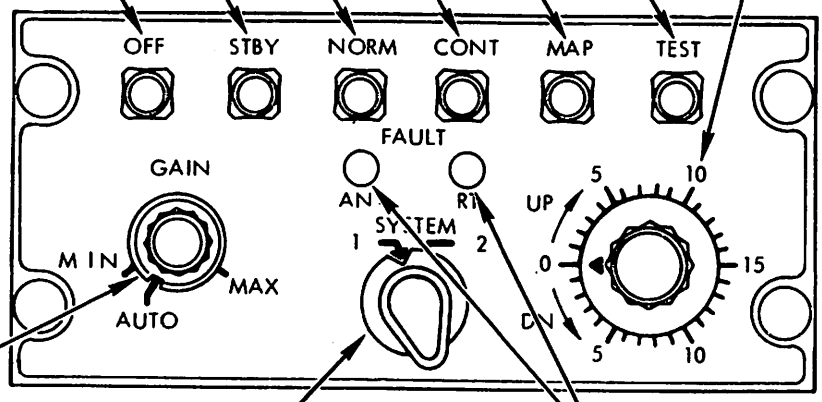
CONT - WEATHER AVOIDANCE MODE.

MAP - GROUND MAPPING MODE.
FAN BEAM.

TEST - TEST PATTERN ON INDICATORS.
FAULT LAMPS ILLUMINATE.

ANTENNA TILT CONTROL

ADJUSTS ANTENNA UP/DOWN 14 DEGREES FROM HORIZONTAL.



GAIN CONTROL

MIN/MAX - ADJUSTS RECEIVER SENSITIVITY

AUTO (DETENT) - AUTOMATIC RECEIVER SENSITIVITY ADJUSTMENT

SYSTEM TRANSFER SWITCH

SELECTED SYSTEM FULLY OPERATIONAL.
OTHER SYSTEM IN STBY.

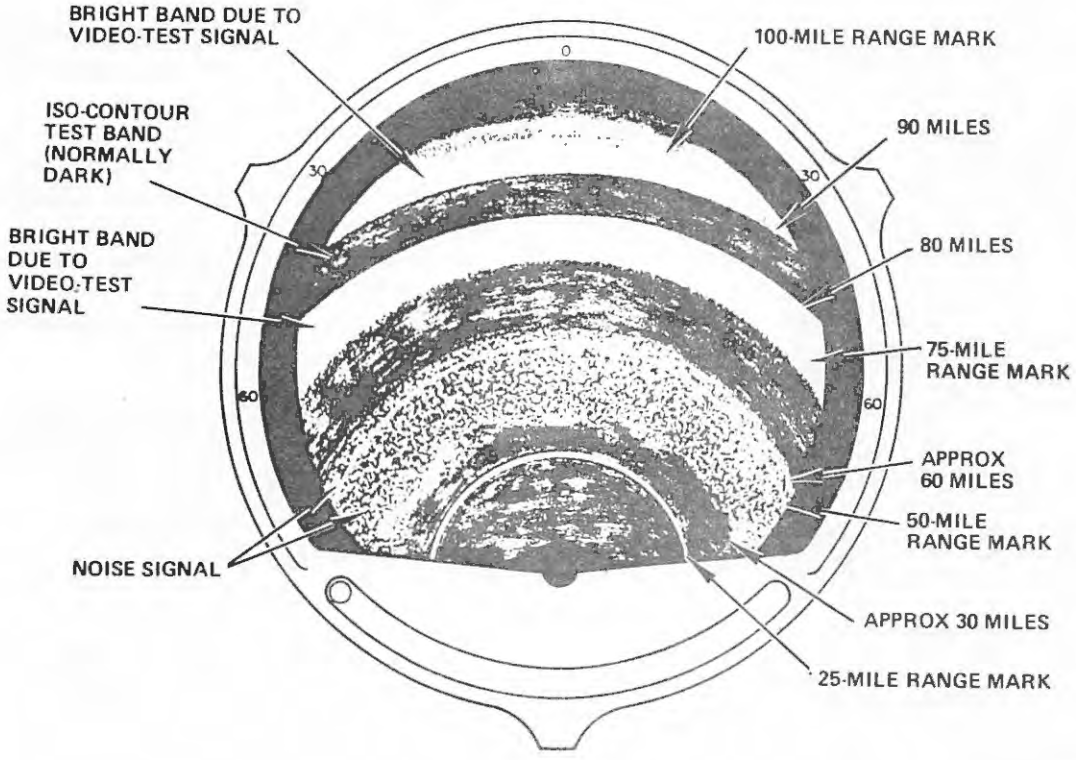
FAULT LAMPS

ANT - ANNUNCIATES FAULT IN ANTENNA CIRCUITS.

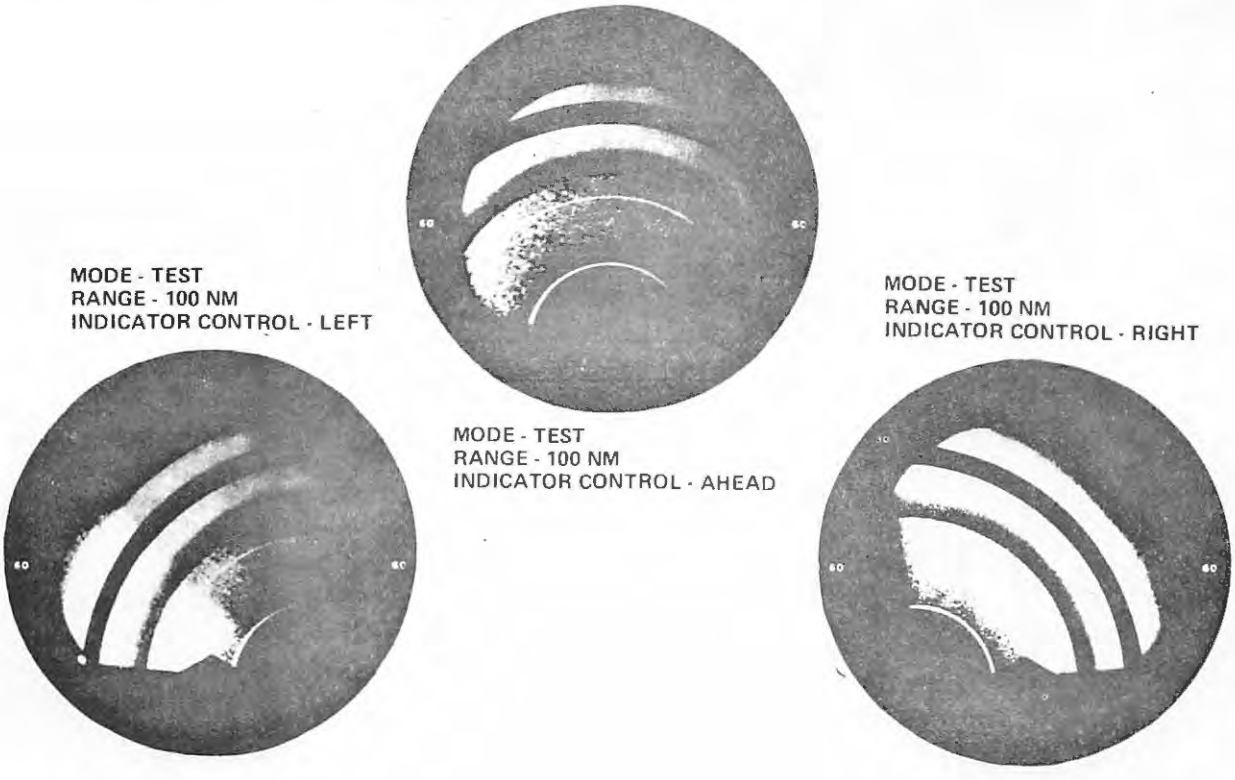
RT - ANNUNCIATES FAULT IN SELECTED RCVR-XMTR.

BOTH - ANNUNCIATE FAULT IN ANTENNA STAB. CIRCUITS.

WEATHER RADAR INDICATOR TEST PATTERN



WEATHER RADAR TEST PATTERN DISPLAY



AIDS

INTRODUCTION

The Aircraft Integrated Data System (AIDS) collects aircraft data from sensors and records it on a Quick Access Recorder (QAR). The mandatory parameters are also supplied to the crash protected or Digital Flight Data Recorder (DFDR). About 500 different parameters are collected.

GENERAL DESCRIPTION

There are 3 Flight Data Acquisition Units (FDAU) each with a capability of accepting 160 different inputs. One FDAU is used for the mandatory parameters and feeds its information to the crash protected recorder (DFDR) which has a capacity of 25 hours and then re-cycles. A second output goes to the QAR via a data management unit (DMU).

The other two FDAU's collect information on engine health and autoland and pass it to the DMU where it is fed to the QAR for recording. In addition a fourth source of information is the Engine Health Fixed Data panel where the serial numbers of the engines have been entered and are available for recording on the QAR.

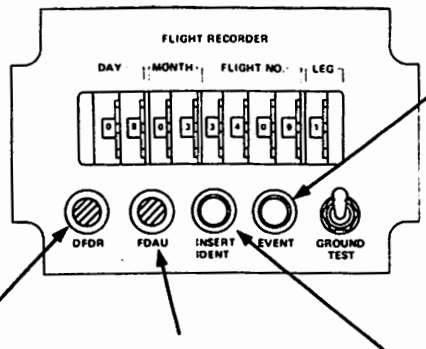
The Data Entry and Display panel in the flight deck may be used by the crew to access the DMU and request a read out of any parameter which is being monitored.

DFDR (DIGITAL FLIGHT DATA RECORDER)

The DFDR is installed in the Aft service centre and attached to it, is an underwater sound locating device. If the recorder is immersed in water the device is activated and will emit a signal for a period of 30 days. It is powered by internal batteries. This signal can be picked up and used to locate the crash recorder and assist in its recovery.

DFDR CONTROLLER

The controller is located on the lower right of the systems station for operation by P3. The illustration shows the function of the controls.



Momentary pushbutton to mark on tape any specific event

DFDR FAIL INDICATOR Indicates failure of DFDR

FDAU FAIL INDICATOR Indicates failure of FDAU

INSERT IDENT Momentary pushbutton for inserting DAY-MONTH-FLT.No.-LEG into FDAU for recording

Q.A.R.

The Quick Access recorder is a cassette tape recorder which has seven tracks each recording for about 1 hour - 7 hours total. After that time the new data is recorded and the old data progressively erased. The cassette is removed at the end of the trip for handing in. If the cassette is even partially removed and then re-inserted it will run back to the beginning of track 1 and erasing of data will take place even though the seven hours have not been used up.

Although the QAR records continuously, certain trigger or cue signals are used to change the parameters for different stages of a flight.

The stages are:

Identification - For 45 seconds after Data insert signal.

Take off roll - Airspeed less than 100 knots.and 2 engines exceed 80% IEPR.

Climbout - End of take off roll.

Cruise - Above FL120 - less than 4 knots change in airspeed - less than 2% change in N3 RPM - Bleed air valves closed, all for a period of at least 2 minutes. Parameters recorded for 10 minutes.

General - Whenever other reports are not being recorded.

Autoland - Below 2300 feet on Radio Alt or AFCS mode flag "LOC" is displayed.

Landing Report - Bogie tilt switch open.

The QAR is located in the right hand wardrobe.

DATA ENTRY AND DISPLAY PANEL

The DEDP is located on the lower right of the systems station alongside the flight recorder controller.

This provides for interrogation of the DMU with a request for a specific parameter which is being monitored, to be displayed on the DEDP. It is, of course, necessary to have a list of the various parameters together with the coded numbers associated with each of the parameters so that the desired signal can be inserted into the panel by the keyboard.

The panel contains two digital readout displays. The upper display has five alphanumeric indicators. Each one will display, by means of a 16 segment light bar system, any letter of the alphabet, any number, plus and minus signs and a question mark. The lower display has six numeric windows which, by a seven light bar indicator can display the numbers 0 to 9.

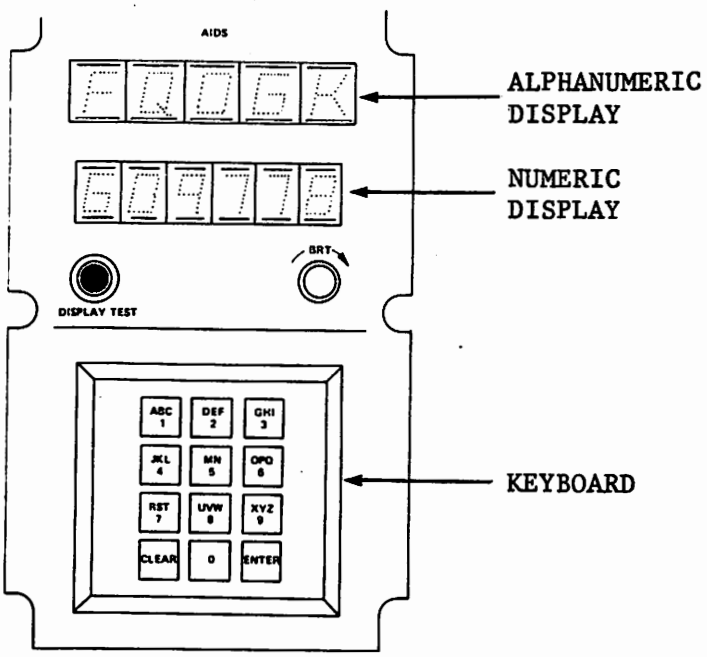
DATA ENTRY AND DISPLAY PANEL (Cont)

Pressing the ENTER button passes the numbers on the display, by pressing the keys, into the computer and also displays information from the computer on the digital readout.

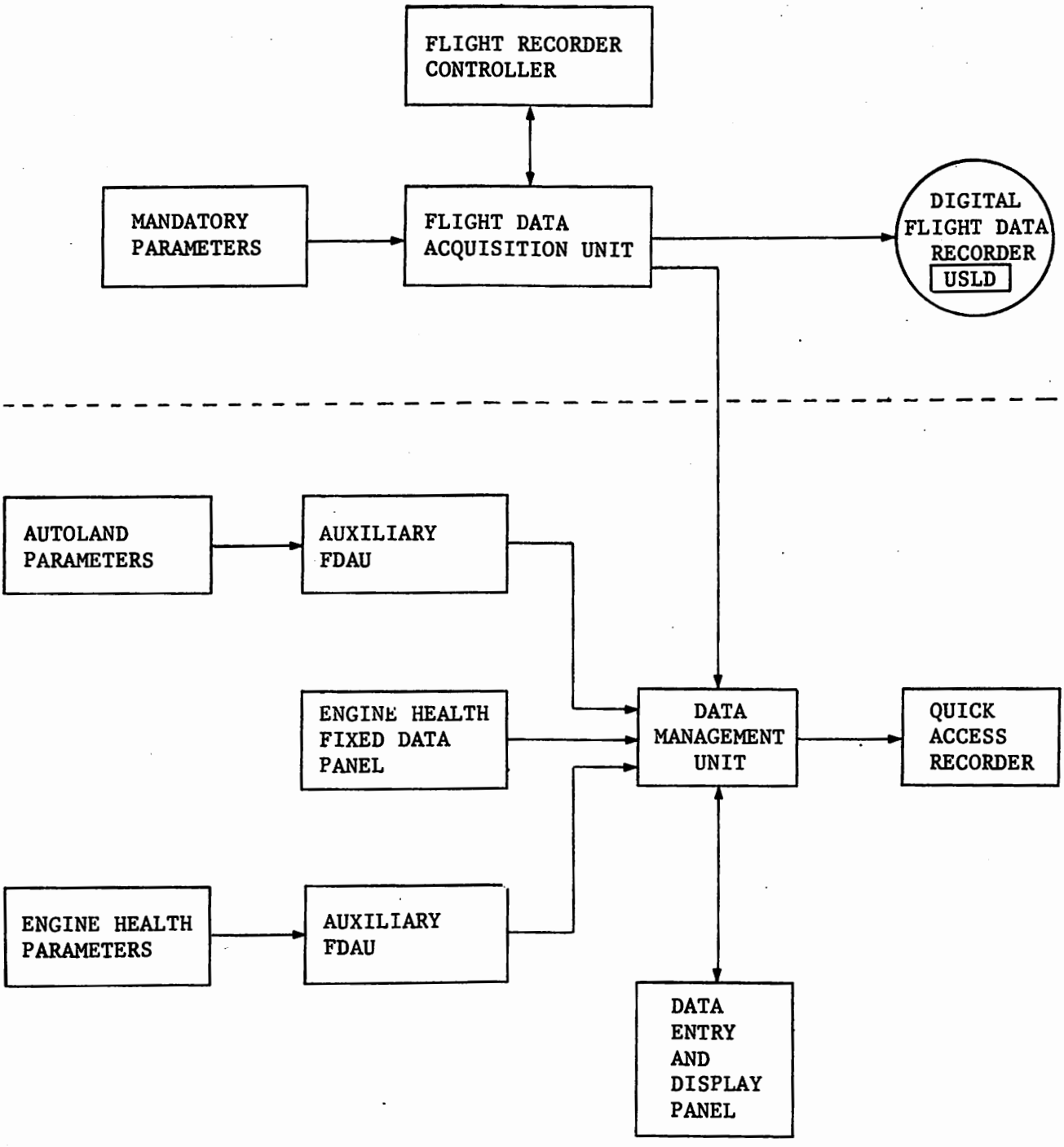
The display test button exercises all light bar segments in all display windows. A panel lights dimming control is also provided.

The CLEAR button, when pressed, clears any pushbuttons depressed since the last entry was made.

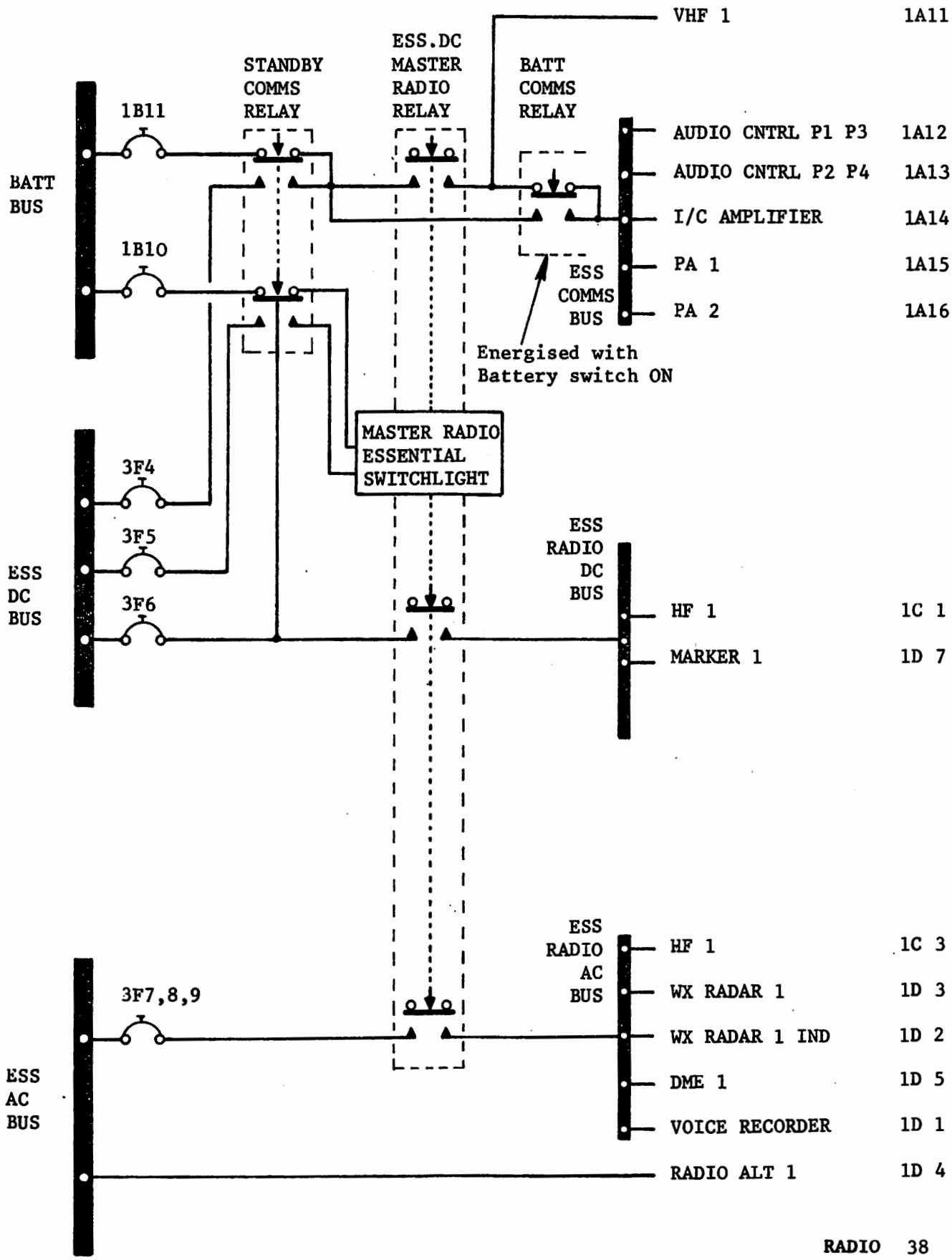
16 segment Light bar Display



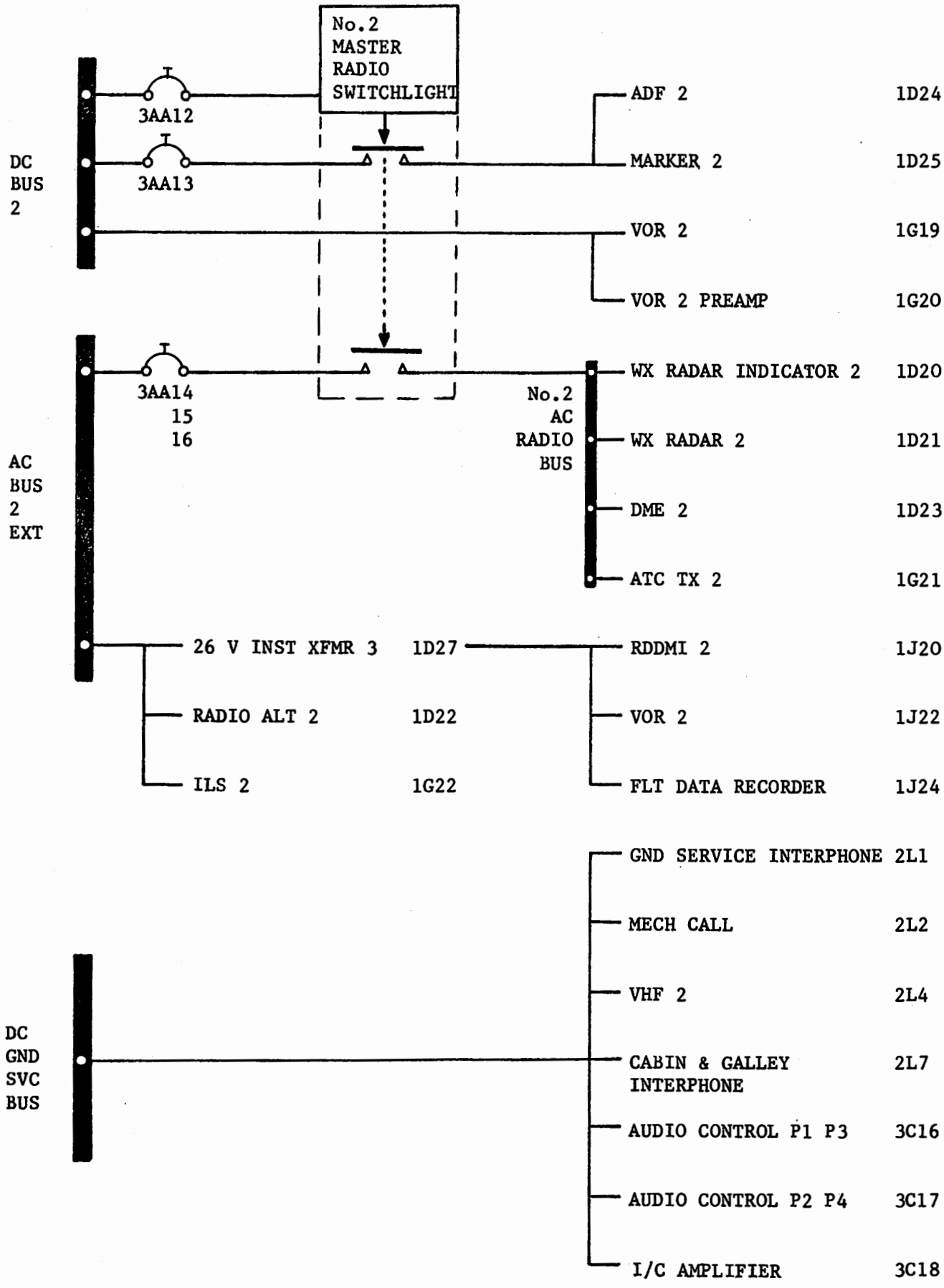
DFDR AND AIDS SYSTEMS



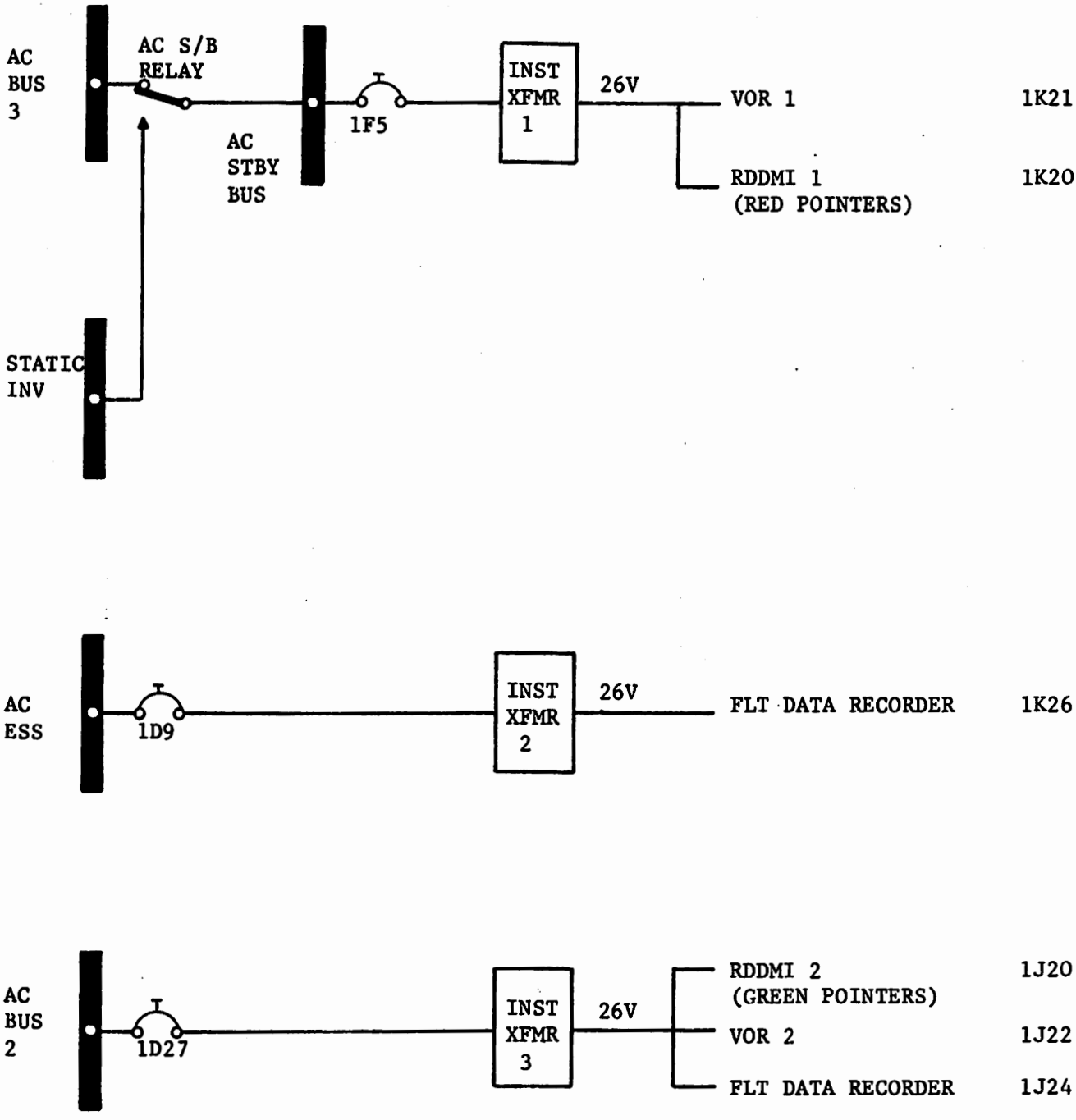
ESSENTIAL RADIO POWER SUPPLIES



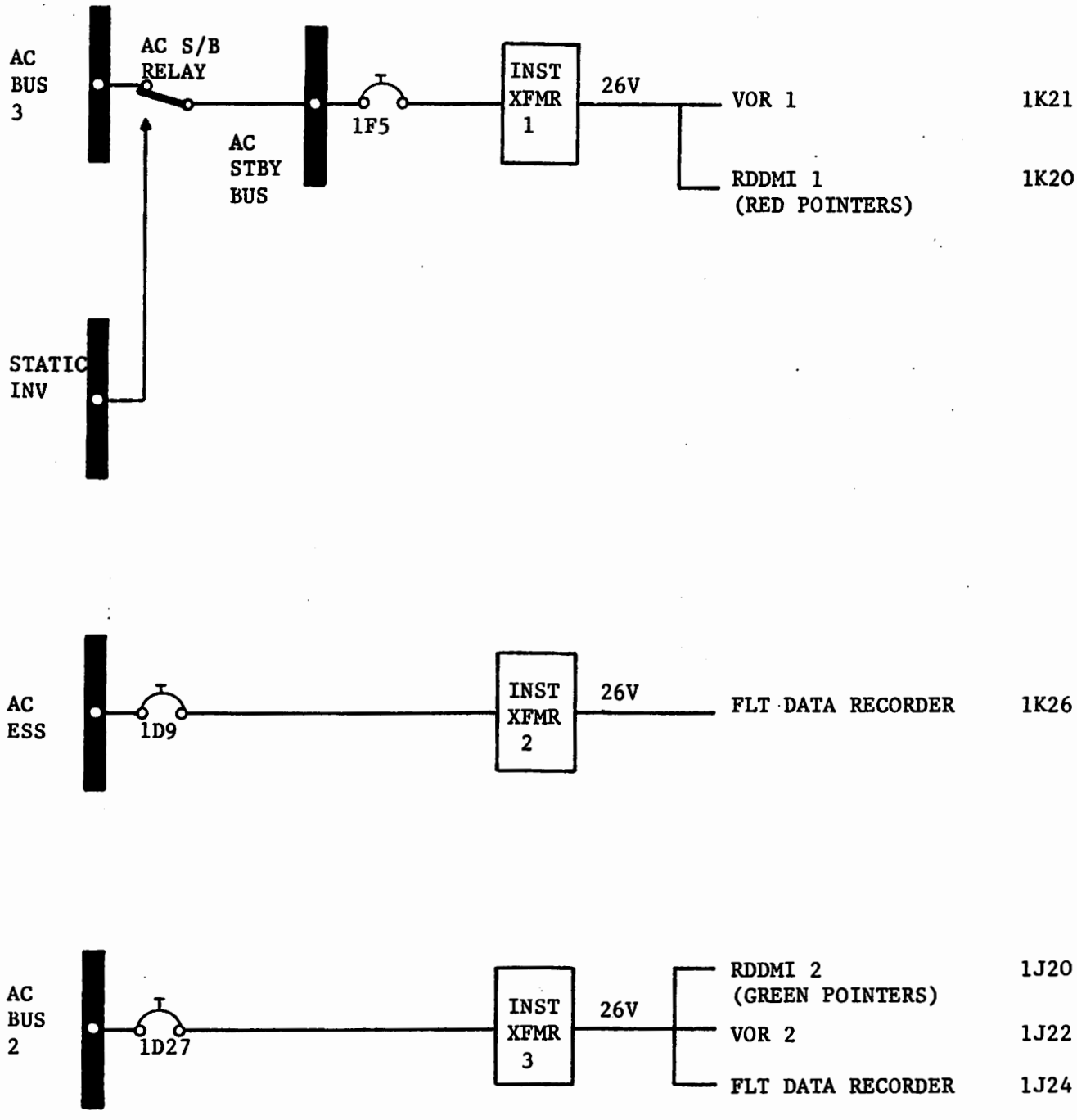
No.2 AND GROUND SERVICE RADIO SUPPLIES



26V AC RADIO SUPPLIES



26V AC RADIO SUPPLIES



FIRE PROTECTION

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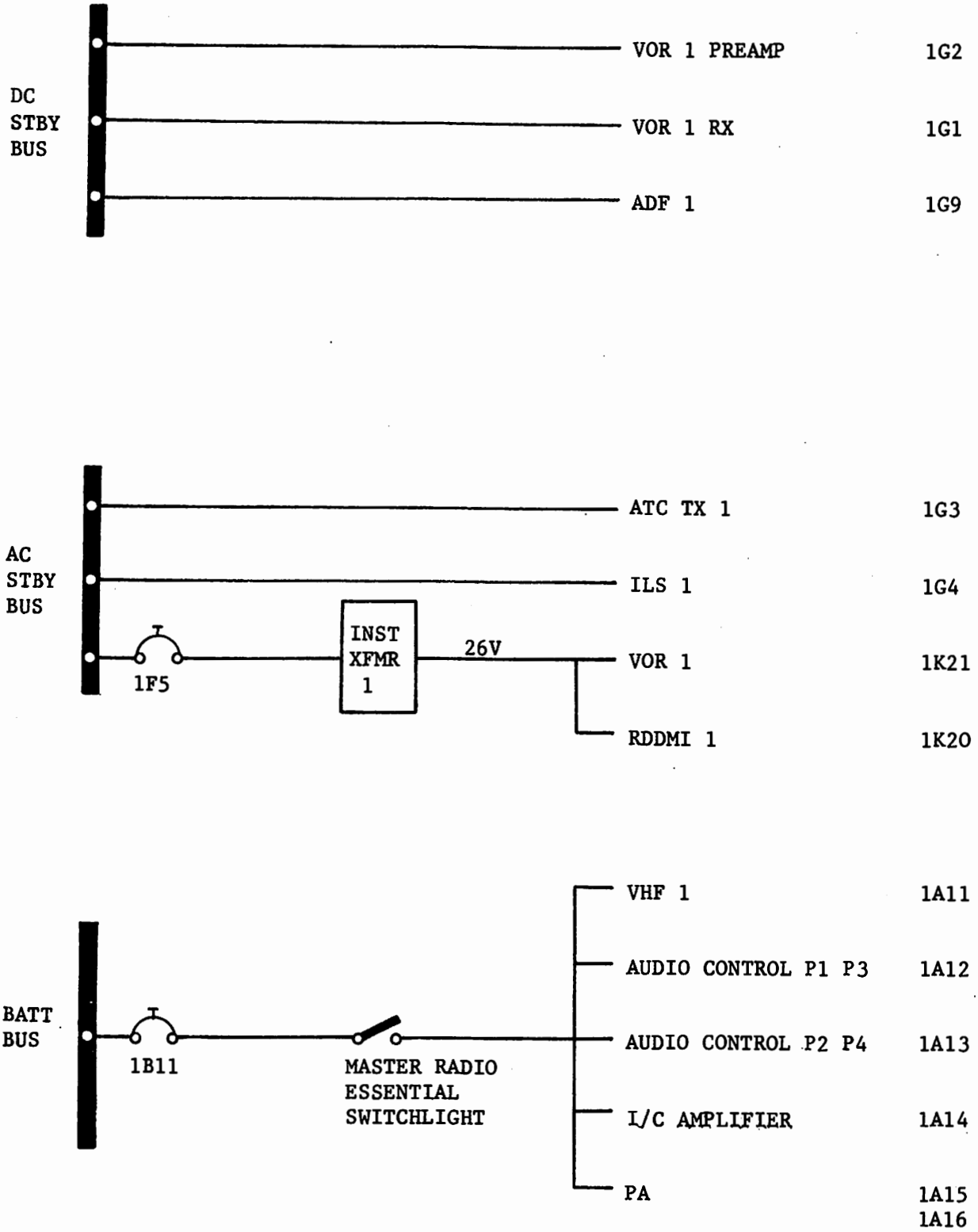
RADIO SUPPLIES AVAILABLE WITH BATTERY AND STATIC INVERTER ONLY



FIRE PROTECTION

GENERAL

The fire protection system provides fire detection, warning and control in the fire-hazard zones:-

Engines (3)
A.P.U.
Main wheelwells.

ENGINE FIRE PROTECTION

General

Firewalls in the power plants isolate fire zones from the aircraft structure. Compartmentation is used to separate combustibles from ignition sources. Fuel and Hydraulic lines and bleed air ducts are fitted with firewall shut-off valves and closures are provided for compartment ventilation openings. Conventional fire access panels are provided on each side of the engine cowlings for fire fighting on the ground.

WARNING SYSTEM

A Master Fire Warning System presents the crew in the Flight Deck with a visual and audible warning of a fire. The visual presentation is from two Master Fire Warning Lights, one at each end of the glareshield.

The aural warning is from a bell.

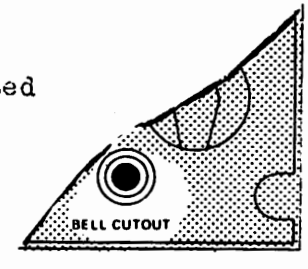
Master Fire Warning Lights

FIRE is illuminated when an engine detection system is activated.

Pressing either switchlight will reset the master fire warning system and silence the bell.

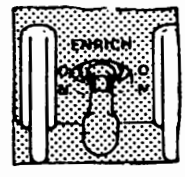
Fire Bell

Fire Warning Bell Cutout Switch (located on the Engine Fire Detection Loop Test Panel). Momentary push button switch that switches off the fire warning bell.



WARNING

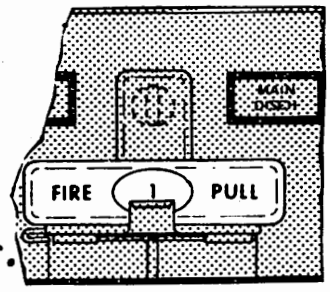
When the Master Fire Warning system operates, an engine fire would be identified by illumination of the associated FIRE PULL handle. Simultaneously the plastic finger guards on the associated Fuel and Ignition Switch will illuminate.



Fire Pull Handle

FIRE PULL - is illuminated by fire detection system (or when being tested).

FIRE PULL - is extinguished when the fire ceases and the detection system cools down and resets itself.



PULLING HANDLE

Fuel	- shuts "Engine Tank Valve" (Except No.2. engine the valve remains open to allow A.P.U. operation if required) shuts "Emergency SHUT-OFF valve".
Hydraulics	- shuts hydraulic pump SHUT-OFF valve shuts hydraulic system FIREWALL SHUT-OFF valve.
Pneumatics	- shuts ENGINE ISOLATION valve.
Ventilation	- shuts accessory inlet vent.
Electrical	- opens GENERATOR FIELD RELAY.
Warning System	- resets Master Fire Warning Lights and Bell.
Fire Extinguishers	- exposes the Fire Extinguisher Discharge Switch.

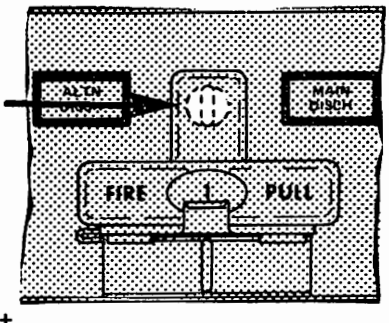
EMERGENCY DRILL

Refer to Check List and Drills for the Engine Fire Drill.

PROTECTION

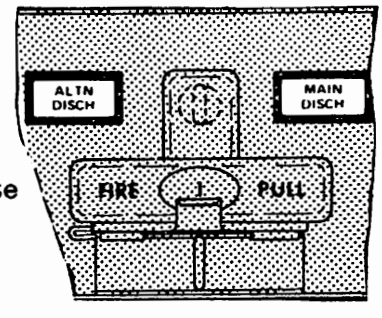
The Fire Extinguisher Discharge Switch is a two position left/right switch which discharges the Main or the Alternate fire bottle.

NOTE: Pulling or attempting to rotate the handle will not operate the fire bottles.



Discharge Indicators

Main and Alternate Discharge Indicators. MAIN DISCH or ALTN DISCH is illuminated by the fire bottles having been fired. They will also illuminate when the fire bottle pressure is low without operating the fire pull handle.



DETECTION

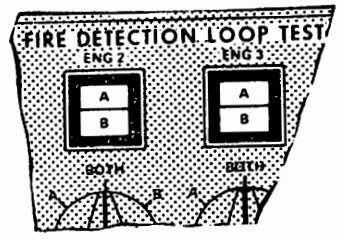
General

The detection system consists of two separate fire sensing loops (designated A and B loop) mounted in parallel in the fire hazard areas.

Electrically each loop is DC supplied and wired together in series so that it will require both loops to sense a fire to operate the Master Fire Warning System.

The sensing loops have indicators and test facilities located on the Fire Detection Loop Test panel at the P_3 Systems Station.

TEST PANEL



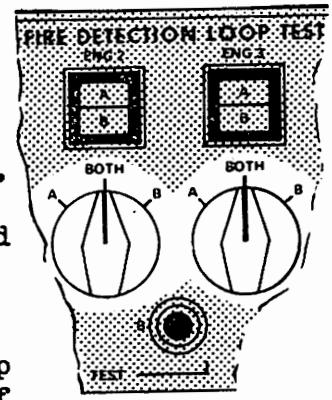
Fire Detection Loop Lights (4)

These are illuminated as follows:-

A and B when the detection system senses a fire.

A or B when the associated test button is pressed.

A or B when there is a short circuit in the associated loop.



Fire Detection Loop Selectors (4)

'BOTH' - Normal position. Activation of both fire loops gives a fire warning. Activation of a single loop illuminates associated amber

M W S

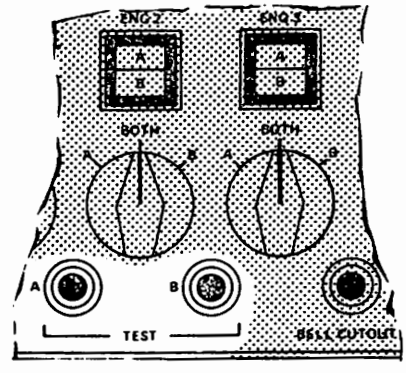
'A' - Selects A loop only (B loop disabled) and activation of A loop will give a fire warning.

'B' - Selects B loop only (A loop disabled) and activation of B loop will give a fire warning.

Fire Detection Loop Test Switch (2)

Momentary switch that tests fire warning circuit by feeding a false fire signal into the selected loop circuit.

Pressed - illuminates loop test lights if the circuit is satisfactory.



FIRE EXTINGUISHERS

General

There are three separate fire extinguishing systems:-

No.1. engine
No.3. engine
No.2. engine and the APU

Each system has two fire bottles, a main and an alternate. No.2. engine and the APU share a system but the two fire bottles are each doubled in capacity. See Fire Protection 11

The fire bottle pressures can be checked by reading pressure guages through a small circular window in the wing engine nose cowlings. The fuselage mounted engine and APU pressure gauges are viewed through a window underside of the rear fuselage just forward of the APU compartment, See Fire Protection 9 & 10

CONTROLS

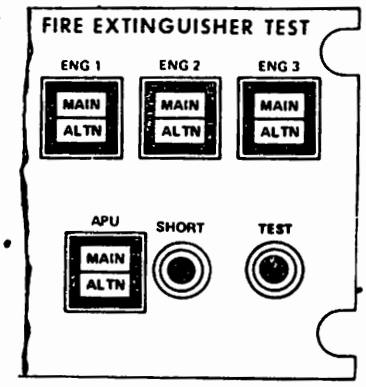
The fire bottle discharge switches as mentioned previously are accessible when the fire pull handle is pulled. The fire bottle switches and the bottle fired indicators are explained in Fire Protection 2.

Thermal discharge indicators are located in the engine cowling and the underside of the rear fuselage. There is one indicator for each pair of bottles. The indicator is a frangible red disc which is ruptured and blown out by a thermal discharge. See Fire Protection 9 & 10

Testing

Fire Extinguisher Test Lights (4)

MAIN and ALTN are illuminated when the Test Switch is pressed to indicate continuity of the fire bottle firing circuits.



Fire Extinguisher Test Switch - when pressed tests the continuity of the fire bottle firing circuits.

Short Switch - with the Test Switch depressed and all MAIN/ ALTN lights illuminated, pressing the Short Switch will extinguish the lights to indicate that there are no shorts in the firing circuits.

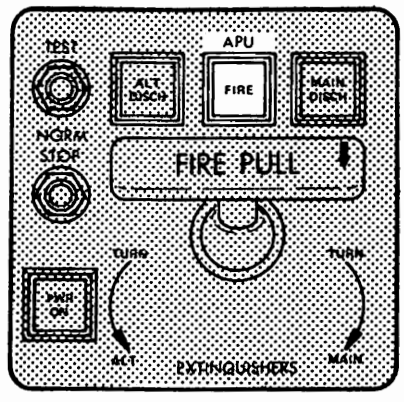
Any lamp remaining ON indicates a short circuit.

A.P.U.
FIRE PROTECTION

General

The A.P.U. is installed in a fireproof compartment, it has its own fire detection system but shares its protection system (fire bottles with No.2. engine as mentioned previously).

WARNING SYSTEM



Detection of a fire in the A.P.U. compartment will operate the Master Fire Warning System (in the same manner as an engine fire).

On the ground the following will also occur:-

The red Fire indicator light on the A.P.U. external control panel will illuminate.

The A.P.U. external fire warning horn sounds.

The A.P.U. automatically shuts down.

The Main fire bottle (shared with No.2. engine) will automatically be discharged.

Flight/Ground

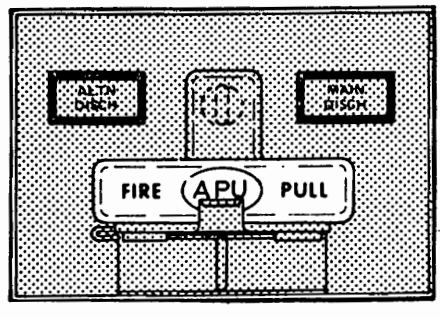
On the ground a single fire detector loop operating will give a full fire warning.

In flight both loops must operate for the same indications.

CONTROLS

There are two A.P.U. Fire Pull Handles, an internal and an external.

Fire Pull Handle (internal) located in the top left corner of the P_3 systems station panel.



CONTROLS (cont.)

When pulled:-

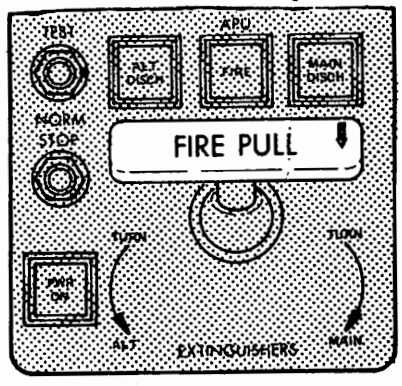
Fuel - shuts the A.P.U. Primary Emergency Shut-off valve, shuts the A.P.U. Secondary Emergency Shut-off valve.

Electrics - energises the A.P.U. stop circuits, opens the A.P.U. generator field circuit.

Ventilation - shuts the A.P.U. doors.

Warnings - silences the Warning Horn and Bell, resets Master Fire Warning lights.

NOTE: If the Master Fire Warning System has been reset by pressing either of the glareshield lights, the bell and the horn would already have been silenced.



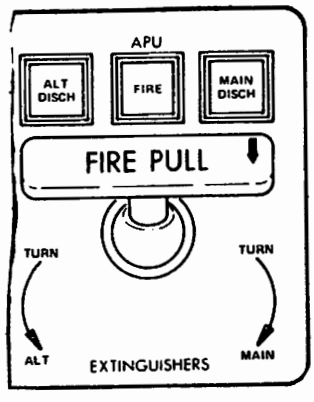
Fire Pull Handle (external) located below fuselage forward of main undercarriage doors. To operate the handle it is pulled downwards rather than outwards.

When pulled:-

It operates the same systems as the internal fire pull handle but excluding Master Fire Warning Lamps and Bell.

PROTECTION

The internal A.P.U. Fire Pull Handle when pulled exposes the left/right fire extinguisher switch and operates in the same manner as the engine fire pull handle, and the relevant MAIN/ALTN discharge indicator will illuminate.



Also, the No.2. engine MAIN/ALTN discharge indicators will illuminate because the fire bottles are shared between the A.P.U. and the No.2. engine.

The external A.P.U. Fire Handle is different to the others when used to discharge the fire bottles.

The handle is rotated clockwise for the MAIN fire bottle and anti-clockwise for the ALTN fire bottle.

PROTECTION (cont.)

The indicators illuminated are:-

MAIN/ALTN on the A.P.U. external panel.

MAIN/ALTN on the A.P.U. internal panel.

MAIN/ALTN on the No.2. engine panel.

AUTO FIRE SHUTDOWN

Automatic Fire Shutdown Arm switch located on the A.P.U. control panel at the P_3 Systems Station.

Its purpose is to arm the automatic A.P.U. shutdown protection circuit.

On the ground the circuit is always armed.

In flight:-

IN - ARMED is illuminated and automatic fire shutdown circuit is armed.

OUT - ARMED is extinguished and automatic fire shutdown circuit is dis-armed. This in no way hinders the operation of the internal or external A.P.U. fire pull handles.

Testing

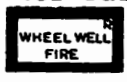
The A.P.U. Fire Extinguishers Test is carried out simultaneously with engine fire bottle testing, see Fire Protection 4.

The fire loop detection test is also carried out with the engine test, see Fire Protection 3.

WHEEL WELL FIRE PROTECTION

Each main wheel well has its own fire detection system.

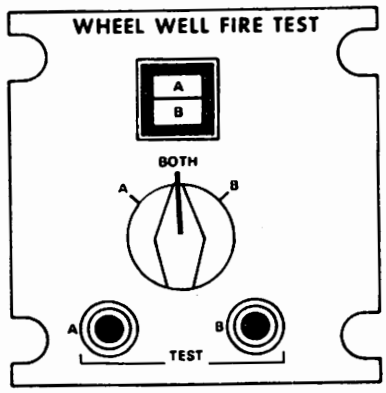
INDICATORS

A fire in either or both main wheel wells will operate the Master Fire Warning System and the associated MWS 

Testing

Wheel well Fire Test:-

Functions in the same manner as the engine Fire Detection Loop Test, see Fire Protection 3.



EMERGENCY DRILL

Refer to the Wheel Well fire drill in the Check List Drill Cards.

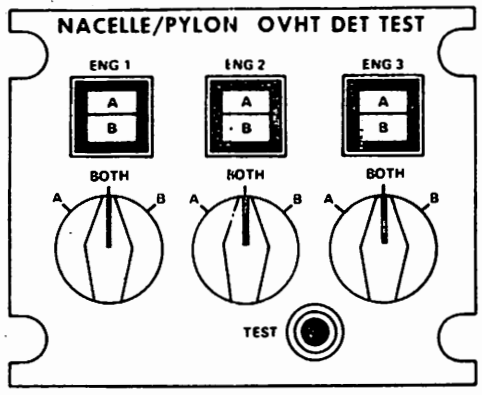
NACELLE/PYLON OVHT

The detection, protection and procedures for a Nacelle/Pylon Ovht are explained in E.C.S. 7.

Testing

The test procedure is the same as the Engine and A.P.U. Fire Detection Loop Test.

The only difference being that there is only a single momentary test push button switch. The test switch tests both the A and B loops.



ENGINE TURBINE COOLING AIR OVERHEAT

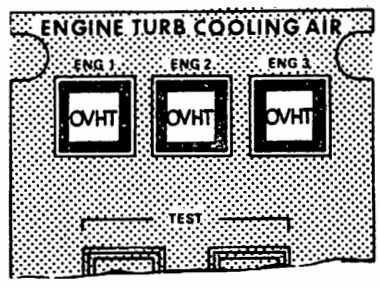
General

Temperature sensors mounted on the engine sample air from the front and rear of the I.P. turbine rotor. At a predetermined temperature the switches will signal the flight deck that an overheat condition exists. The electrical circuit is arranged so that both switches must sense an overheat to bring on the warning.

INDICATORS

Engine Turbine Cooling Air Ovht Lights (3). The red light will illuminate for the associated engine when an overheat condition exists.

Associated MWS

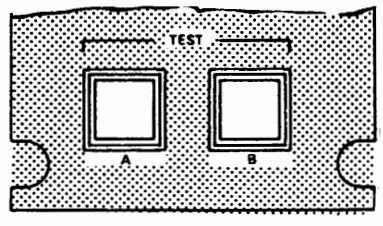


A future modification will illuminate the plastic finger guards of the associated Fuel and Ignition switch.

CONTROLS

Testing

Engine Turbine Cooling Air Overheat Test Switches (2). Momentary switchlights designated 'A' and 'B'.

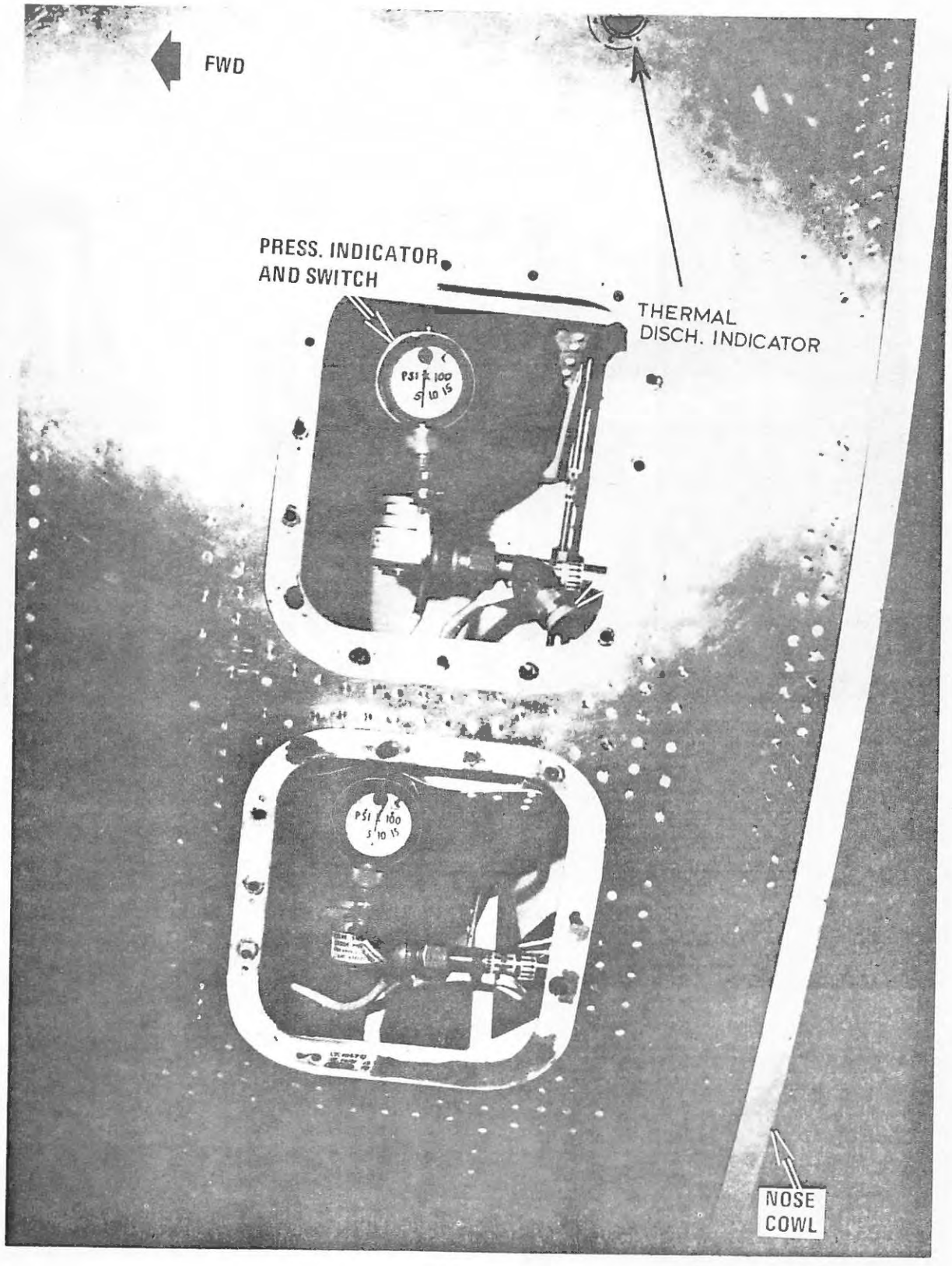


'A' and 'B' pressed - all red OVHT legends illuminate and the associated MWS.

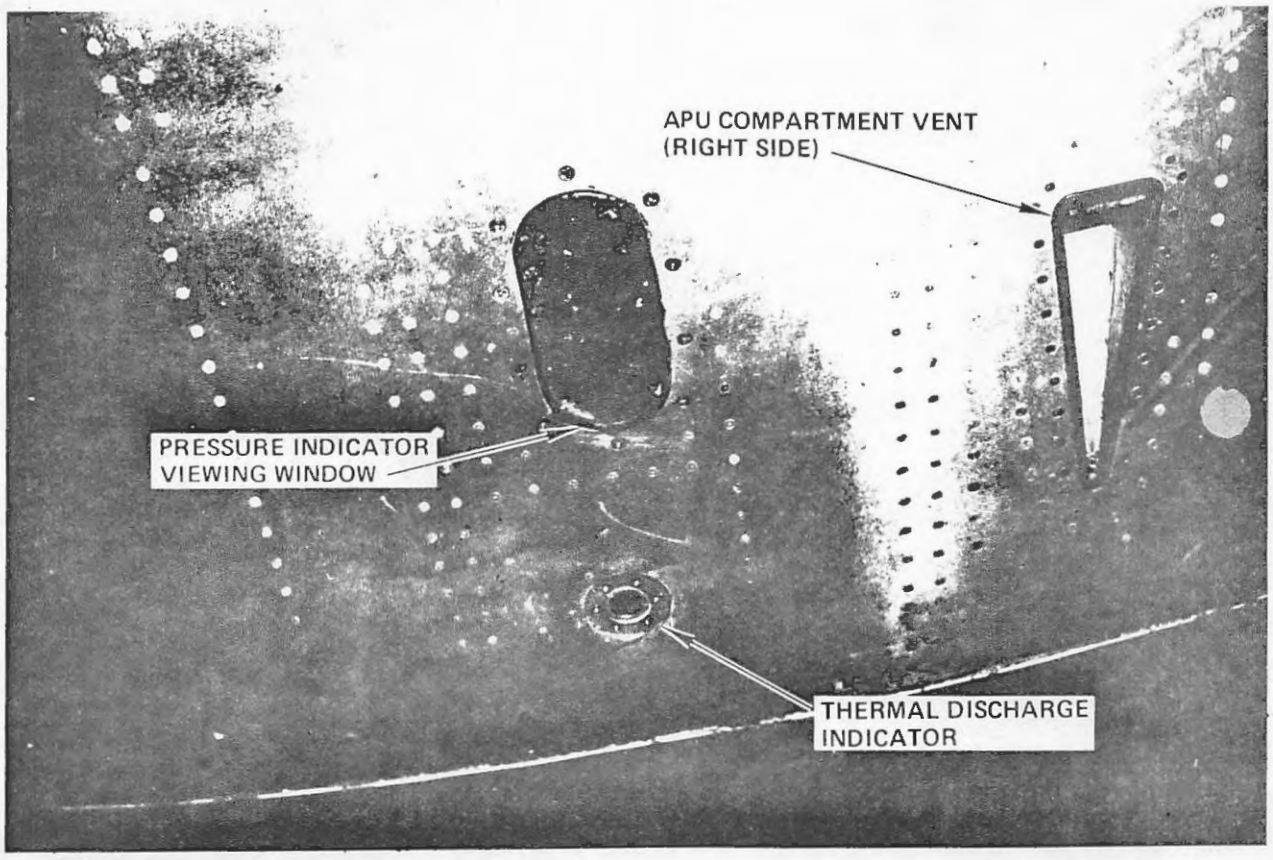
'A' pressed - ('B' circuit disabled) any fault in the 'A' circuit will illuminate the OVHT light for that engine.

Test switch 'B' operates correspondingly.

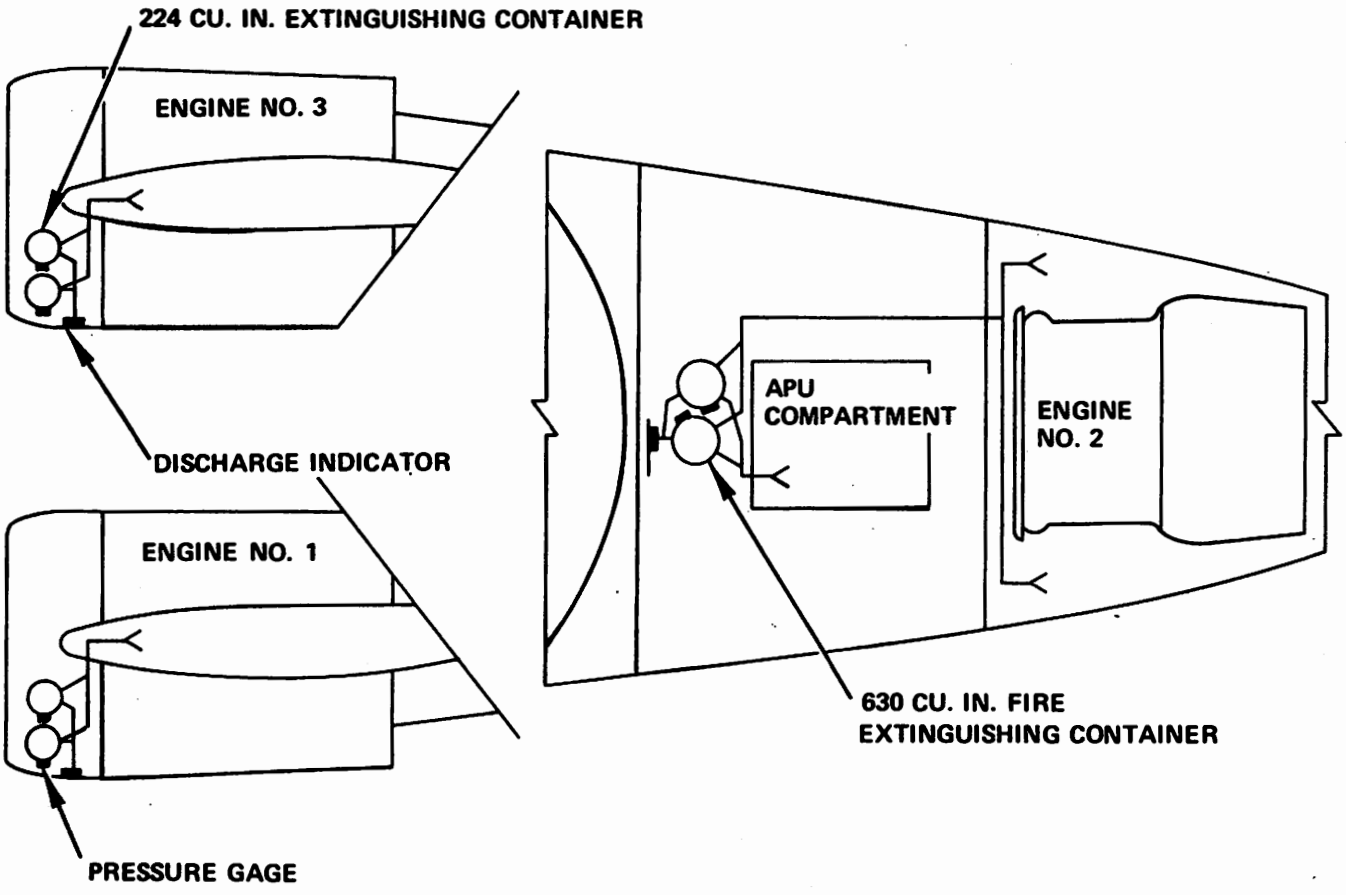
WING ENGINE FIRE BOTTLES



FUSELAGE FIRE BOTTLE INDICATORS



FIRE EXTINGUISHING LAYOUT



ICE AND RAIN PROTECTION

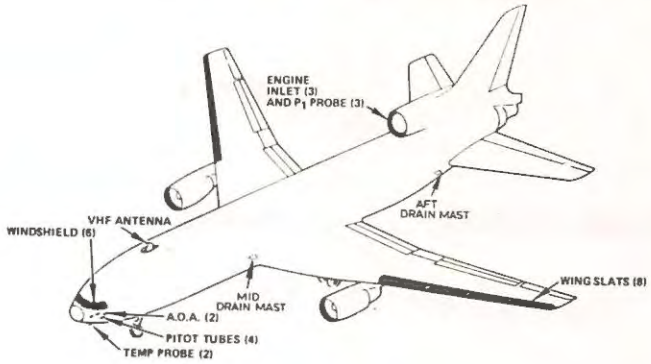
GENERAL

When the aeroplane enters icing conditions an automatic ice detector warns the crew by illuminating the amber MWS ICING light.

A time delay will keep the light illuminated as long as icing conditions exist and for 60 secs. after they cease.

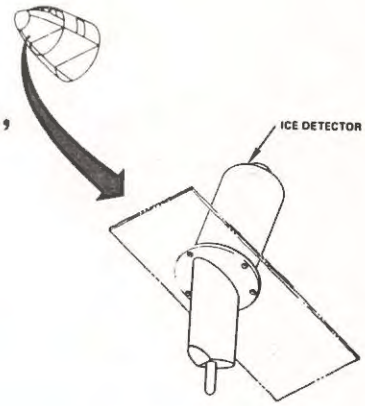
The areas protected are :-

PNEUMATIC ANTICING	ELECTRICAL ANTICING
Wing leading edge slats.	Windshield and side windows.
Engine air intake cowlings.	Air data probes.
VHF antenna mast.	Water/waste system drain masts.



ICE DETECTOR

The Ice Detector system consists of a probe fitted to the left side of the fuselage just aft of the radome for the detection of ice accumulation, an ice sensor, an electronic control box and the amber MWS ICING warning light.



WING ANTICING

General

Wing anticing is provided by two independent systems, one for each mainplane. There is no crossfeed between each system.

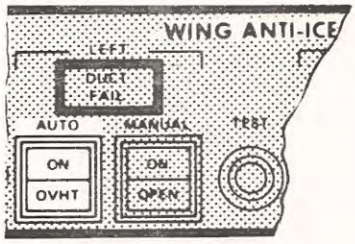
Leading Edge Slats (8)

The four outboard leading edge slats on each mainplane are anticed by hot air. Normally, regulated engine bleed air from the engines provides wing anticing. However, APU bleed air may be used. Air flow is controlled by the Wing Anticing Control Valve. The valve is a dual purpose valve. It operates as a shut-off and pressure regulating valve. The valve is electrically energised and pneumatically controlled. Loss of electrical power will prevent the valve opening and, if already open, the valve would close.

A main undercarriage air/ground sensing circuit renders wing anticing inoperative on the ground.

CONTROLS AND INDICATORS

The switches and indicators are located on the Wing Anti-ice panel on the pilots overhead panel.



Automatic Control

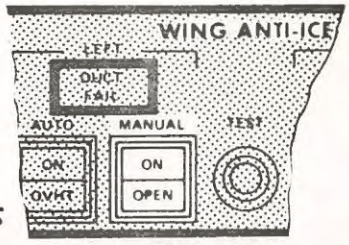
Automatic Switch:-

IN - ON is illuminated by the switch position. The wing anticing control valve is electrically energised to open.

OUT - ON is extinguished and the wing anticing control valve de-energised.

OVHT - is illuminated to indicate excessive wing slat temperature.

Manual Control



Manual Switch:-

IN - ON is illuminated by the switch position. The automatic control is by-passed and the wing anticing control valve will open fully and remain opened.

OUT - ON is extinguished. Manual mode is de-activated and the wing anticing control valve closes if Automatic Switch is not at on.

OPEN - OPEN legend is illuminated by the wing anticing control valve being open in either Auto or Manual mode.

Testing

Test Switch:-

Momentary push-button switch. Its purpose is to test the system on the ground; an air supply must be available for testing.

"Pressed" - OPEN legend illuminates indicating that the wing anticing control valve has opened.

The Auto or Manual switchlight must also be latched in during a test.

Duct Failure

DUCT FAIL is illuminated when an overheat exists in the area around the supply duct.

Associated MWS Amber

NORMAL MANAGEMENT

To select wing anticing press in the Auto switch light and note that the Open legend (in the Manual switchlight) illuminates, the Open light will cycle ON/OFF under 'Auto' control due to operation of heat sensors which will close the shut-off valves when slat skin temperature reaches the maximum limit and re-open the valves when the skin temperature falls below the minimum. The frequency will depend on ambient conditions.

ABNORMAL MANAGEMENT

Refer to Vol. I Flt. Management, Ice and Rain Protection.

ENGINE ANTICING

-

General

Hot air tapped from the engine intermediate compressor is delivered at a controlled pressure to the air intake cowling and P_1 probe to prevent ice formation.

The air pressure is regulated by an Engine Anticing Control Valve in a similar manner to the Wing Anticing Control Valve.

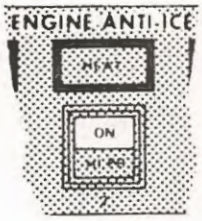
CONTROLS AND INDICATORS

The switches and indicators are located on the Engine Anti-icing panel on the pilots overhead panel.

Control Switch

IN - ON is illuminated by the switch position, the system is selected on. The engine anticing control valve is energised to open.

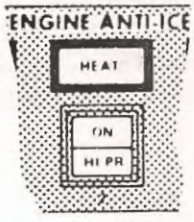
OUT - ON is extinguished, the system is switched off.



Heat Lamp

GREEN - The heat lamp illuminates to indicate normal pressure and flow in the duct to the engine air intake cowling. The lamp is independent of the control switch position. It is signalled by a duct pressure switch and has its own electrical supply.

HI-PR - HI-PR (High Pressure) legend is illuminated indicating that a higher than normal pressure exists in the engine air intake cowling leading edge. The legend is independent of control switch position.



NORMAL MANAGEMENT

To select engine anticing, press in the ON switchlight and note the green heat lamp illuminates indicating that the pressure in the cowling leading edge is normal. On the ground with the throttle closed the green heat lamp may not illuminate. There will be adequate air flow for engine anticing. To check the heat lamp advance the throttle, the lamp should illuminate by 75% N_3.

ABNORMAL MANAGEMENT

Refer to Vol 1 Flight Management Ice and Rain Protection.

VHF ANTENNA MAST ANTICING

The VHF antenna mast on top of the forward fuselage receives bleed air from the air conditioning system to prevent icing. The air is tapped from No.2. and No.3. air conditioning packs just before it enters the primary heat exchanger. A weight-on circuit operated by the Nose Undercarriage Sensor prevents the VHF antenna being anticed on the ground.

The air supply is controlled by two shut-off valves. Either one will provide sufficient air for anticing.

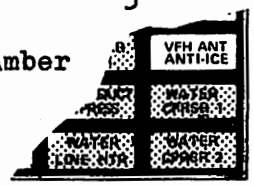
CONTROLS

There are no direct control switches, the system is switched ON automatically by selecting No.2. Engine Anticing, provided No.2. and/or No.3. pack flow control valves are open and the aircraft is airborne.

INDICATORS

The system cannot be monitored but if both shut-off valves fail to open, then a warning is displayed at the P_3 Systems Station on the annunciator panel:-

Amber



WINDSHIELD ANTICING

General

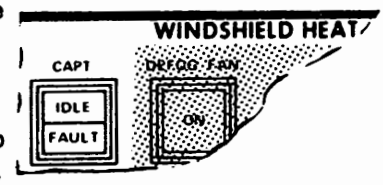
The six flight deck windows are electrically heated, see Ice and Rain Protection 11. The two windshields are heated to a low temperature level (IDLE) whenever there is electrical power connected to the aeroplane and to a higher level when selected by switches on the Windshield Heat Panel.

WINDSHIELD ANTICING CONTROLS

CAPTAINS WINDSHIELD HEAT CONTROL SWITCH

OUT - IDLE is illuminated whenever power is applied to the aircraft and indicates switch position.

Low temperature warm up cycle is being applied.



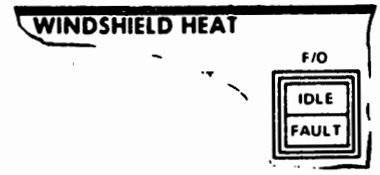
IN - IDLE is extinguished.

Normal high level temperature control systems operating.

FAULT - FAULT legend illuminates for a faulty control unit
or
heating element burned out.

FIRST OFFICER'S WINDSHIELD HEAT CONTROL SWITCH

Operates in the same way as the Captain's.

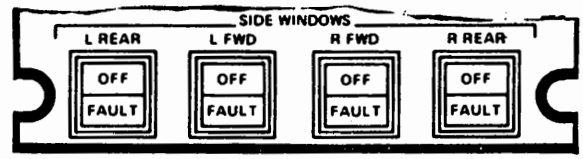


SIDE WINDOW HEAT CONTROL SWITCH

OUT - OFF is illuminated by switch position and window heating is switched off.

IN - OFF is extinguished, heating is in operation.

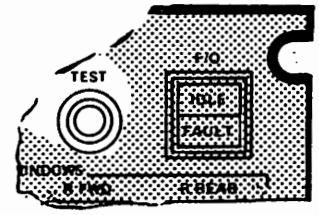
FAULT - Same as the Captain's



WINDSHIELD HEAT TEST SWITCH

Testing

With windshield heat IN or OUT and side window heat switches IN, pressing test switch tests windshield and side windows.



Test results are:-

Normal - all six fault lights cycle on and off at 1 to 2 H_Z

Control Circuit Fault - fault light on steady.

Overheat Control Circuit - fault light flashes then goes out.

Heater Element burned out - fault light is on prior to test; during test fault light cycles ON and OFF at 1 to 2 H_Z.

WINDSHIELD DE-FOGGING

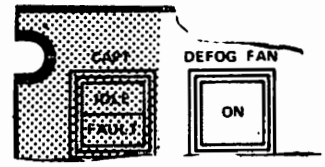
General

The de-fog fan blows flight deck air on to the two windshields and a portion of the adjacent right and left side windows to augment the effects of the windshield heat system.

DE-FOG FAN CONTROL SWITCH

IN - ON is illuminated by switch position and the fan runs.

OUT - ON is extinguished and fan stops.



NORMAL MANAGEMENT

After a cold soak or if the inside of the windshields are covered with condensation, switch on the de-fog fan.

AIR DATA ANTICING

General

There are four pitot static probes fitted to the forward end of the fuselage. The Captain's and First Officer's each have a left and right probe. Each probe has two heaters, one for the probe the other for the mast. See Ice and Rain Protection 12.

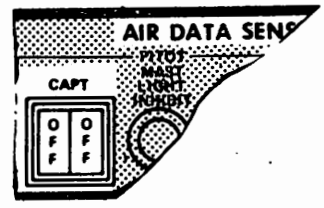
CAPTAIN'S PITOT HEAT SWITCH

IN - OFF is extinguished and the masts/probes are being heated.

OUT - OFF is illuminated.

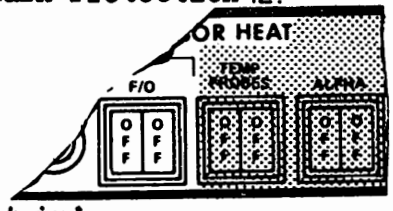
OFF - OFF legend illuminated with mast or probe heater failure with switch latched in.

The left OFF legend is illuminated by the left pitot static probe and the right OFF legend from the right pitot static probe. See Ice and Rain Protection 12.



FIRST OFFICER'S PITOT HEAT SWITCH

Operates in the same way as the Captain's.



MAST LIGHT INHIBIT SWITCH

OFF legend illuminated (in Captain's or First Officer's Pitot switch) indicates pitot/mast heaters have failed.

Pressing the Mast Light Inhibit switch extinguishes OFF legend only if the mast heater has failed.

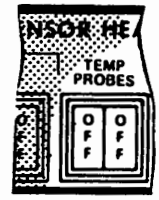
OFF will remain illuminated if the pitot heater has failed.

TOTAL AIR TEMPERATURE PROBES (TAT)

General

There are two total air temperature probes, one fitted to the left and the other to the right of the forward fuselage, each probe has a single heating element.

TEMPERATURE PROBE POWER SWITCH



IN – OFF is extinguished and the probes are being heated.

OUT – OFF is illuminated.

OFF – With the switch latched in the OFF legend illuminates for a heater failure.

The left OFF legend is illuminated by the left temperature probe and the right OFF legend is from the right temperature probe. See Ice and Rain Protection 12.

ANGLE-OF-ATTACK (ALPHA) SENSOR ANTICING

General

Two Alpha probes are fitted to the forward fuselage one on the right the other on the left. Each probe is fitted with two heaters, one to rapidly raise the probe to its normal operating temperature, the other will maintain the temperature.

CONTROLS

ALPHA SWITCH

IN – OFF remains illuminated until each probe reaches normal operating temperature then goes out, the time taken depending on the OAT.

OUT – OFF is illuminated.

OFF – If the OFF legend remains on indefinitely after switching on or comes on after having reached normal operating temperature, a heater has failed.

The left OFF legend is illuminated by the left Alpha probe, the right OFF legend is from the right Alpha probe. See Ice and Rain Protection 12.

NORMAL MANAGEMENT

Switch on the system as required.

ABNORMAL MANAGEMENT

After receipt of a heater failure, i.e. OFF legend illuminated, switch off the applicable stall warning system. One heater on its own may not be sufficient to keep the probe anticed.

WATER LINE ANTICING

General

Electric heaters are provided to protect all water lines passing through the unheated areas of the aircraft.

The water line heaters are automatically heated when AC electrical power is applied to the aircraft. There are no controls or indicators for these lines on the flight deck.

One exception to the above is the fresh water supply and drain lines although these lines are automatically heated they do have an indicator light at the P_3 systems station. The fresh water drain lines terminate at two drain masts, a Mid and an Aft both are electrically heated. Each mast has a switch light for control and indication of heater operation.

Fresh Water Supply and Drain Lines

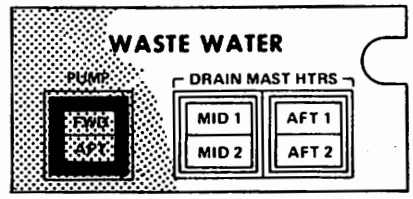
General

Each unit has two thermostatically controlled heating elements to antice the line.

Indicator

Water Line Htr. - amber lamp located on the P_3 systems station annunciator panel.

The lamp will illuminate for a heater failure in any unit. On applying electrical power to a cold soaked aircraft the light may be ON and the time taken for it to extinguish will depend on O.A.T.



DRAIN MAST ANTICING

CONTROLS

DRAIN MAST HEATER SWITCHES

IN selects the No.1. heater, OUT selects the No.2. heater. When the temperature reaches the normal operating level the legends will extinguish, the time taken depending on the OAT.

NORMAL MANAGEMENT

With electrical power to the aircraft, either No.1. or No.2. heater will be ON depending on the switchlight position.

ABNORMAL MANAGEMENT

The legends may cycle ON/OFF during use but if a legend remains ON for longer than a few seconds, select the other heater.

RAIN PROTECTION

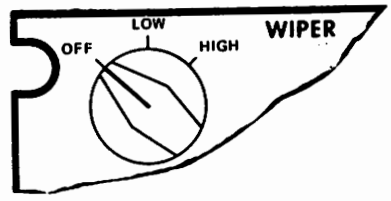
WINDSHIELD WIPERS

Independent two-speed windshield wiper controls are provided for the Captain and First Officer.

Operation of windshield wipers on a dry window is not recommended.

WINDSHIELD WIPER CONTROL SWITCH (CAPTAIN'S)

Controls ON, OFF and speed of Captain's windshield wiper.



WINDSHIELD WASHER

General

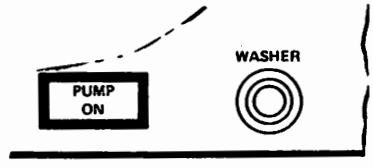
The windshield washer system sprays washer fluid on to the windshield panels. The system is used with the windshield wipers to clean the windshields.

CONTROLS

WINDSHIELD WASHER PUMP SWITCH (CAPTAIN'S)

Momentary switch, when pressed operates washer pump and applies fluid to both windshields. To stop the pump the switch is pressed again.

Volume is controlled by knobs located on the left and right side panels.



WINDSHIELD WASHER PUMP LIGHT

PUMP ON - is illuminated to indicate that the pump is operating.

RAIN REPELLENT

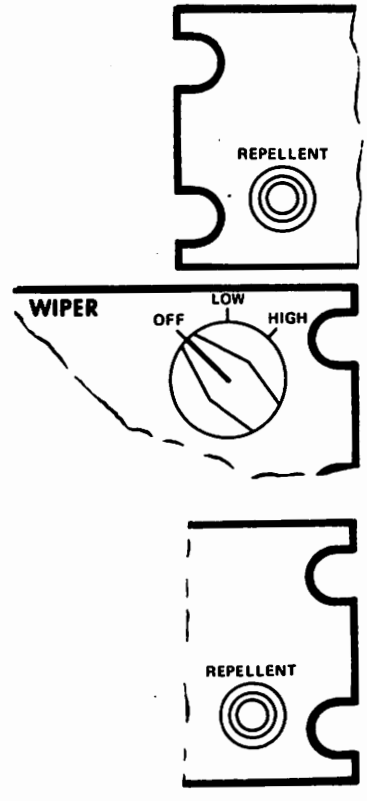
General

The rain repellent system is used with the windshield wipers to improve visibility during heavy rain. Depending upon airspeed and rain conditions, each application should be adequate for 2-5 minutes.

The liquid repellent is stored in a throw-away type aerosol container located in the left console area of the flight deck. A container stores approximately 75 applications from fully charged.

A window-type indicator displays a refill float when the fluid is low and a pressure gauge, with green and red areas, indicates a go-no-go condition. If the refill float is visible or the pressure gauge is in the red area, the container is empty.

Rain repellent sprayed on to a dry windshield reduces visibility.



RAIN REPELLENT SWITCH (CAPTAIN'S)

Pressing momentary switch releases a measured amount of fluid to the respective windshield.

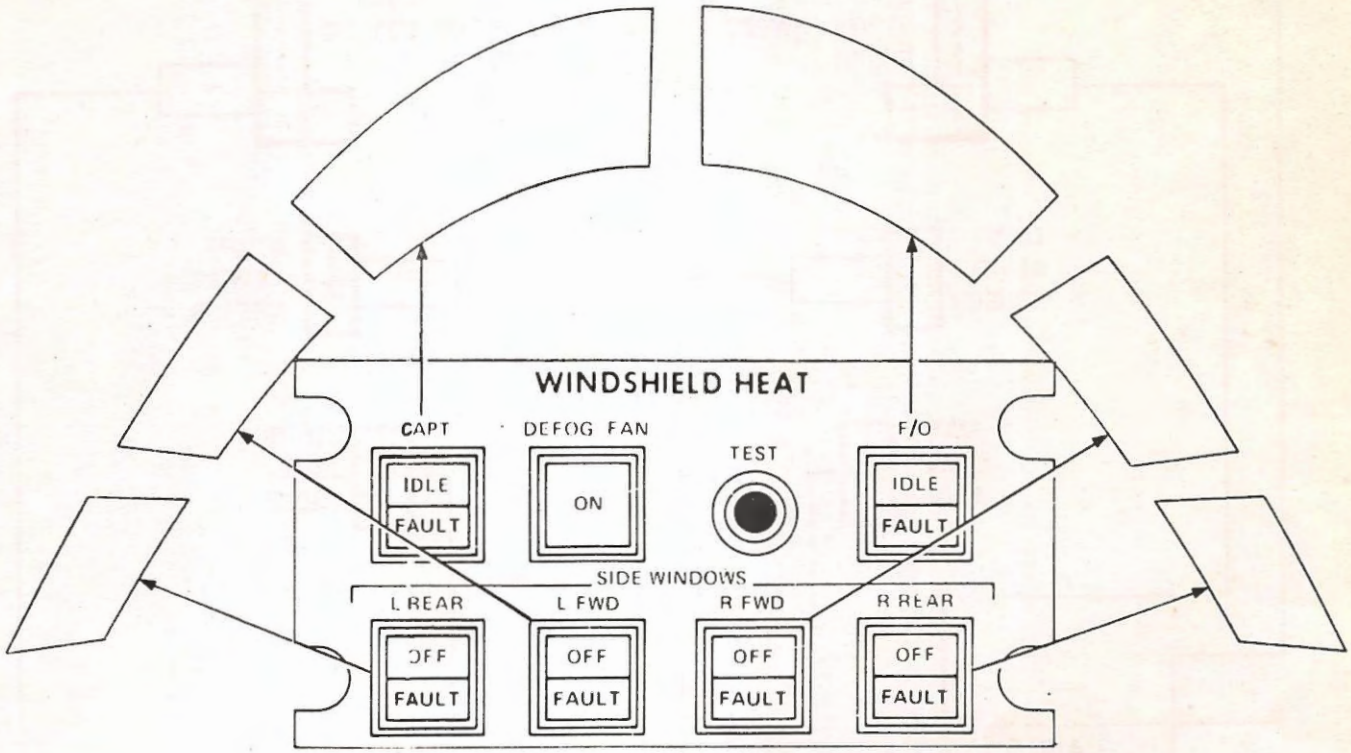
WINDSHIELD WIPER CONTROL SWITCH (FIRST OFFICER'S)

Operates in the same manner as the Captain's.

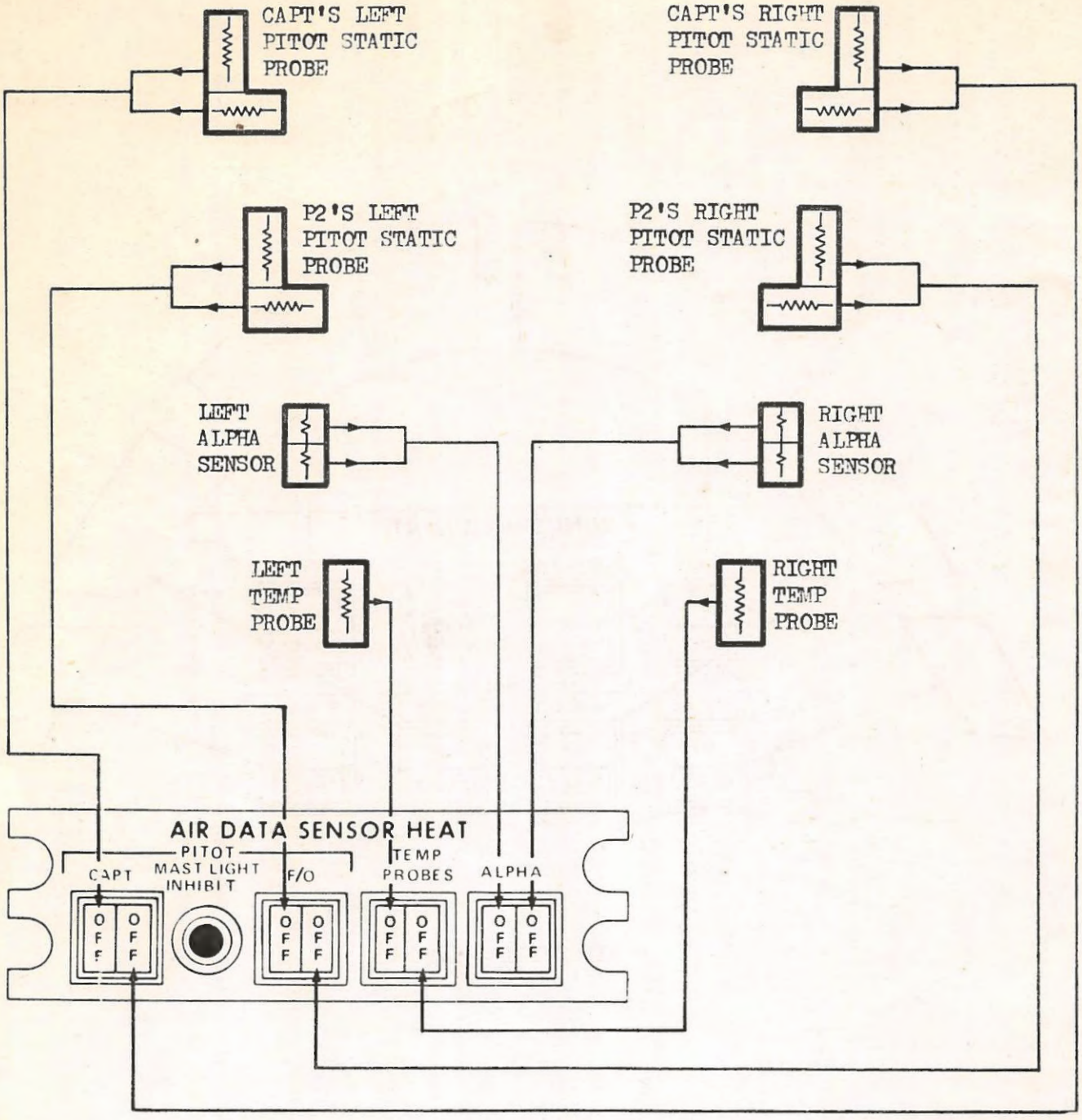
RAIN REPELLENT SWITCH (FIRST OFFICER'S)

Operates in the same manner as the Captain's.

NOTE: There is no windshield washer switch for the First Officer.



WINDSHIELD HEAT



NOTE:- Latching in any switchlight will switch on its associated Left and Right probes' heaters.

AIR DATA SENSOR HEATING ELEMENTS AND FAILURE LEGEND ARRANGEMENT